the OIL AND GAS JOURNAL

SEPTEMBER 17, 1956

Annual

PIPELINE

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- Lines & stations
- Controls
- Operations

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WHAT DO YOU LOOK FOR IN PIPELINE VALVES?

Positive Shut-Off?

Rockwell-Nordstrom valves are lubricant sealed for *positive, continuous* shut-off on heavy crudes or light gases.

Fast Operation?

Rockwell-Nordstrom valves close with just a quarter-turn. Pressurized lubricant makes operation smooth, easy . . . jacks the plug for *instant* operation.

Clean Design?

Rockwell-Nordstrom valves have *no bonnet or body cavities* to collect valve jamming sediment. Flow is clean as a whistle . . . minimum pressure drop.

Low Maintenance?

Rockwell-Nordstrom valves have *no exposed seats* to wear out . . . lubricant reduces wear for longer life at lower cost.

Versatility?

Rockwell-Nordstrom valves are available in sizes to 30", API ratings to 10,000 lb. They can be ordered with wrench, gear or power operators to fit any need.

Low Cost?

Rockwell-Nordstrom valves cost no more to buy than ordinary valves. And they *stay* reliably on stream at *lower* cost than *any* other valve.

You get all the performance and economy you look for in pipeline valves when you specify "Rockwell-Nordstrom." Get the complete story from your nearby supplier, or write Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

Lubricant Sealed For Positive Shut-Off

40th YEAR *of lubricated plug valve leadership*

A Glance Ahead . . . . at press time

These trends will make TOMORROW'S NEWS

Reserves are being lined up for a new $50-$75 million natural-gas pipeline to run north or east out of Oklahoma. A Texas independent is back of the deal. He is buying up gas in an area where the going price is 10 cents per M.c.f. "We are paying considerably more than 10 cents," he says. The pipeline would serve an existing distribution system whose reserves are being depleted.

California refiners will start soon on a second round of adding catalytic reforming equipment, needed to keep abreast of higher octane motor fuels. First to announce new units for their Los Angeles refineries probably will be either Union Oil Co. (most likely) or Shell Oil Co.

Wilshire Oil Co. will take the lead in marketing 100-octane gasoline, according to reports. It will have a superfuel on the market before the first of the year.

A shorter work week will be the target for organized labor next year.

Some unions already are putting out feelers in that direction. The Government Printing Office, the only federal agency that bargains with its employes, has secured a comptroller general's ruling that the work week can be adjusted as well as wages. The need to prevent mass unemployment due to automation is one of the arguments advanced for a 35 to 37-hour week.

An all-out campaign for oil imports legislation will be launched in Congress next year.

Hearings starting before a congressional subcommittee this week will be the jumping-off spot for charges that present law is inadequate. Independent producers, jobbers, coal interests, and others will attack the voluntary program to limit imports as a failure.

The Justice Department may get into the fight over sale of Universal Oil Products Co.

The antitrust division has asked for information from the Guaranty Trust Co., the Independent Refiners Association of America, and several individual refiners who are protesting the sale. First question to be settled, it is indicated, is whether there are legal grounds for the Government to get into the case.

Fluid coking has settled down to a routine operation at Esso Standard Oil Co.'s Baltimore refinery. The 10,000-bbl. per day unit now holds the record for continuous operation: 135 days as of this week. But because of the firm heavy fuel market, Esso is short of feed stock and the coker is operating at a fraction of its total capacity.

Look for a major U. S. refiner to enter Western Canada with a new refinery. Plans are firm but still too premature for official announcement.

You can expect the entry of a brand new chemical company into the petrochemical business. This company is looking hard at the Gulf Coast and is planning to start with basics like propane, butane, etc.

The OIL AND GAS JOURNAL

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OIL AND GAS PIPELINES • REFINING • PETROCHEMICALS
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. . . an integrated magazine serving an integrated industry

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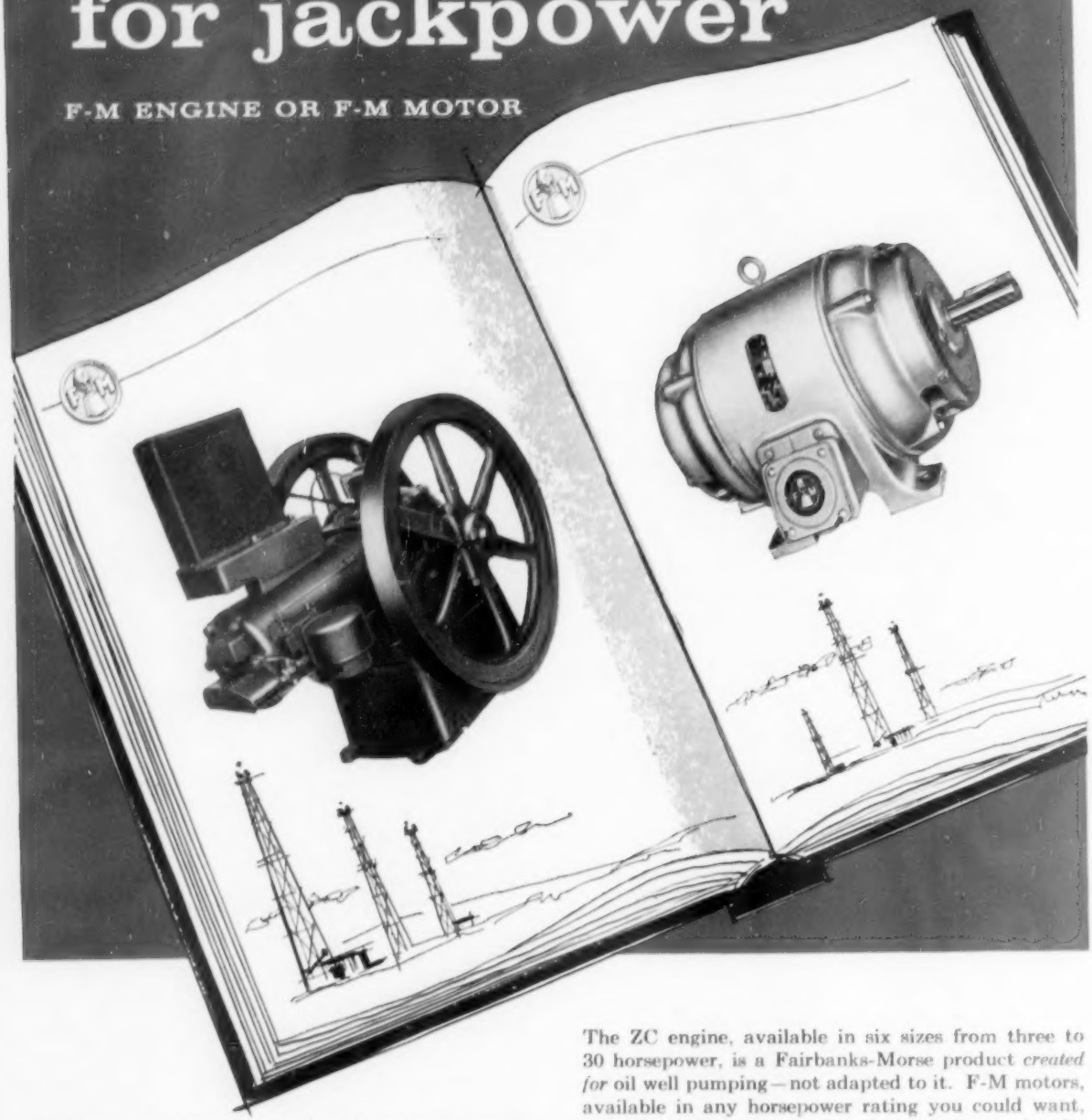
for jackpower

F-M ENGINE OR F-M MOTOR



Whether you pump your well with gas or kilowatts, there is the just-right Fairbanks-Morse prime mover for the job. Today's Fairbanks-Morse engines are the result of the design and manufacturing experience of 70 years; today's Fairbanks-Morse motors have a similar tradition of half a century.

The ZC engine, available in six sizes from three to 30 horsepower, is a Fairbanks-Morse product *created for* oil well pumping—not adapted to it. F-M motors, available in any horsepower rating you could want, will have the torque or slip characteristics to handle the load demand peculiar to a pump jack. Either will do its job efficiently and economically.

See your local supply store or write Fairbanks, Morse & Co., Oil Field Division, 600 South Michigan Avenue, Chicago 5, Illinois.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

OIL FIELD EQUIPMENT · PUMPS · SCALES · ELECTRIC MOTORS · GENERATORS · LIGHT PLANTS · DIESEL, DUAL FUEL AND GASOLINE ENGINES · MAGNETOS · DIESEL LOCOMOTIVES

B.F.Goodrich

No danger of burst with B. F. Goodrich rotary drilling hose

B. F. Goodrich builds a rotary drilling hose you can put out of your mind when you put it on your rig. No more worries about hose blowouts, shutdown time, damage to drilling bit or rig, or possible injury to the crew. Here's the story—inside and out—on this stronger, longer-lasting Highflex rotary drilling hose.

Spiral-wrapped cable wires make it resistant to bursts, qualify it for Grade C (5000 lb. test pressure) American Petroleum Institute. Hose ends are reinforced with additional plies of wire and fabric to protect against bending stress at the couplings. Extra strength here means extra safety for your crew and rig—no hose blowouts at the coupling.

Strong as it is, B. F. Goodrich Highflex is still the most flexible hose made for heavy-duty service. It's easy to attach to the rig, hangs well from the standpipe, coils easily without kinking.

The thick, tough cover on Highflex resists gouges, scrapes, tears. Sun, wind and rain will not weaken it. Oily mud will not cause swelling or rotting of the tube.

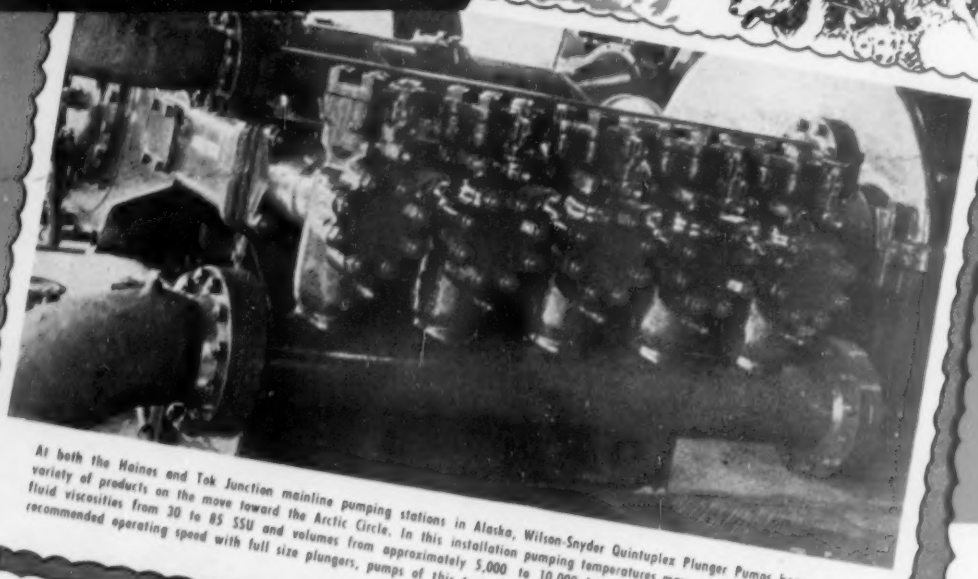
You'll find B. F. Goodrich Highflex hose at leading supply stores in the oil field, or at any of these B. F. Goodrich warehouses: Los Angeles, Great Bend, New Orleans, Hobbs, Oklahoma City, Tulsa, Dallas, Houston, Odessa, Wichita Falls. *B. F. Goodrich Industrial Products Company, Dept. M-735, Akron 18, Ohio.*

B.F.Goodrich

INDUSTRIAL PRODUCTS

Wilson-Snyder No. 558-P Quintuplex Plunger Pumps

...chosen for another critical pumping job!



At both the Haines and Tok Junction mainline pumping stations in Alaska, Wilson-Snyder Quintuplex Plunger Pumps keep a wide variety of products on the move toward the Arctic Circle. In this installation pumping temperatures may vary from 80 to —20° F, fluid viscosities from 30 to 85 SSU and volumes from approximately 5,000 to 10,000 bpd per pump at 1,200 psi. At maximum recommended operating speed with full size plungers, pumps of this type are capable of handling up to 17,500 bpd at 1,270 psi.

IN THE FIRST PUMPING STATION of the Alaska Products Pipe Line at Haines, Alaska . . . as well as at Station No. 3, some 450 miles up the line at Tok Junction . . . Wilson-Snyder Quintuplex Plunger Pumps were selected because only reciprocating, positive-displacement pumps can handle both light and heavy liquids, at wide viscosity and pressure variations, in summer and winter temperatures, at uniformly high efficiency.

THESE ARE THE PUMPS . . . that were designed specifically for difficult pipe line applications. The one-piece, fully-enclosed, rib-reinforced power frame provides a rigid support for the crankshaft, which is mounted in heavy-duty roller bearings. The fully-annealed, cast-steel fluid end with open-type fluid chambers, avoids differential pressures on internal walls.

PERFORMANCE — The working order of the five overlapping plunger strokes results in a smooth discharge pressure at all speeds. Large, streamlined fluid passages further minimize resistance and turbulence, contributing to high pumping efficiency.

MAINTENANCE — Horizontal pump construction with large stuffing box openings affords ready access for packing adjustments. Two-piece plunger construction facilitates installations of new packing when needed and plungers can be serviced separately. A combination splash and pressure system supplies ample lubrication to all power end working parts.

WHEN PUMPING PROBLEMS . . . are being analyzed, give your nearest "Oilwell" Pump Specialist an opportunity to quote on Wilson-Snyder pumps that will meet your requirements . . . . MOST ECONOMICALLY

OIL WELL SUPPLY
DIVISION UNITED STATES STEEL CORPORATION
Executive Offices — **DALLAS, TEXAS**

with Pipeline Equipment Specialists at

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USS

"OILWELL"
TRADE MARK

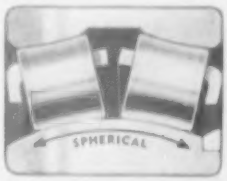
UNITED STATES STEEL

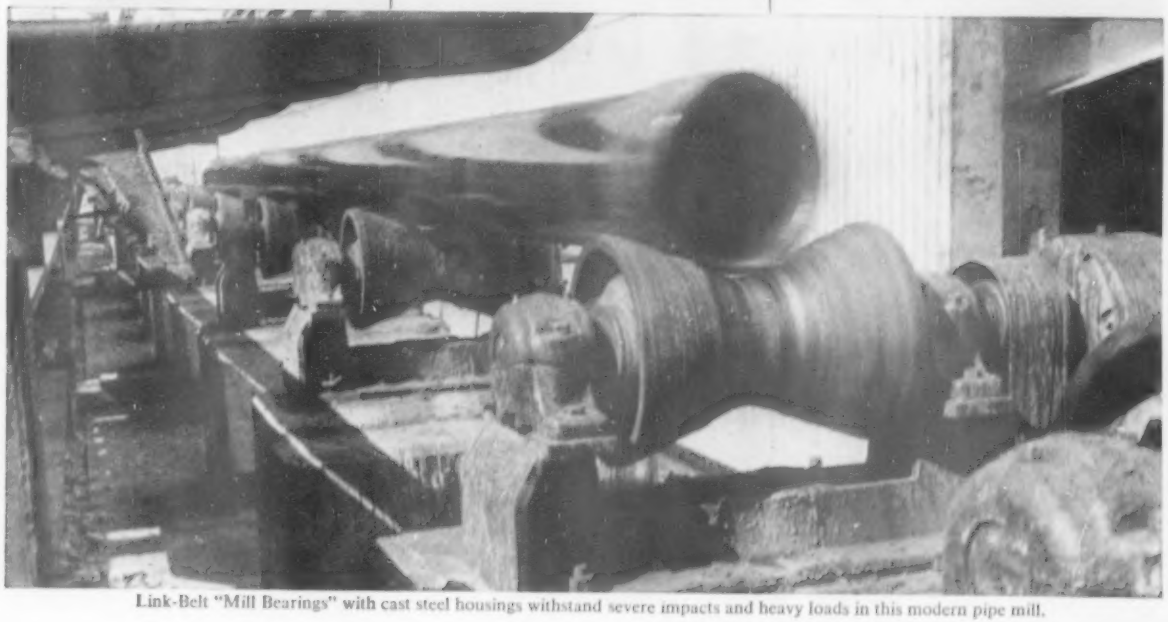
MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

SUPER-RUGGED CAST STEEL HOUSING. Proper positioning of cap on base is assured by large-size dowels. Four heat-treated thru-bolts and serrated steel nuts firmly clamp cap and base together.

CHOICE OF SEALS. Spiral labyrinth steel seals, left, are for oil or grease lubrication and heat conditions. Combination felt and synthetic rubber contact-type seals, right, for grease lubrication.

SELF-ALIGNING ROLLER BEARING is self-contained and adjusted at the factory—needs no shims or alignment rings at installation. Design assures free rolling under even the toughest conditions.

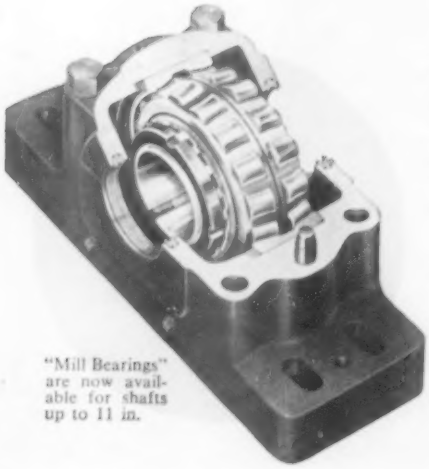




Link-Belt "Mill Bearings" with cast steel housings withstand severe impacts and heavy loads in this modern pipe mill.

"Mill Bearings" with cast steel housings

designed by Link-Belt to take industry's heaviest loads and hardest impacts



"Mill Bearings" are now available for shafts up to 11 in.

● To stand up to the sudden shocks and impact loads met in steel mills, mines, foundries, oil field applications and on heavy equipment, Link-Belt has designed the extra tough "Mill Bearing." It's the precision Link-Belt self-aligning roller bearing mounted and protected in a durable cast steel housing.

Thoroughly-proved Link-Belt "Mill Bearings" maintain full load capacity even with shaft deflections and misalignment often existing in extremely heavy service. And their simple, efficient design assures long life and free rolling.

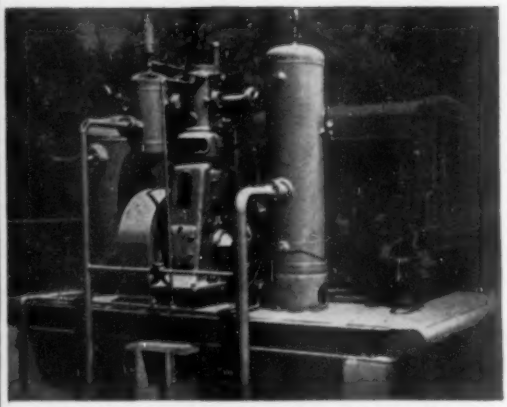
Link-Belt makes industry's most complete line of ball and roller bearing blocks. So whatever you need, you'll find the answer in this quality line. Ask any of the 40 Link-Belt offices or an authorized stock-carrying distributor for Data Book 2550 and Book 2565A on "Mill Bearings."

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 21, Odessa, Tex., Shreveport, La., Los Angeles 33, Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields.

THE ONLY MODERN-DESIGN COMPRESSORS FOR GAS BOOSTER OPERATION



Joy WGB-110 Gas Compressor. Inlet pressure 150 psig; Discharge pressure 500 psig. Capacity 1.028 MMCFD. "Packaged" by McNamar Boiler & Tank Co., Tulsa.

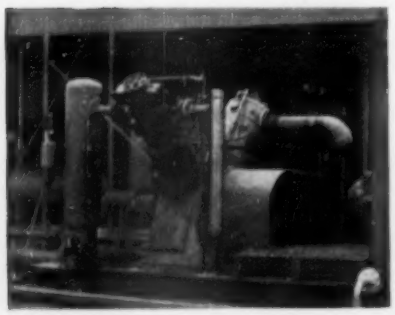
JOY *Packaged* GAS COMPRESSORS

Modern Joy Packaged Gas Compressors are backed by a century-old reputation for low maintenance and long service. These *time-proved* features make Joy Compressors the most reliable for gas gathering, repressuring, or gas lifting:

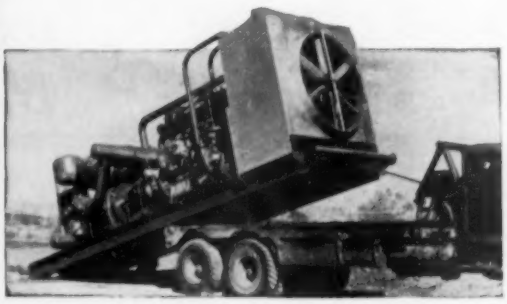
- **Field-replaceable cylinder liners.**
- **Field-replaceable crosshead guides.**
- **Patented Joy "Dual-Cushion" valves.**
- **Full force-feed lubrication.**
- **Anti-friction main bearings.**

Joy Gas Compressors are available in space-saving vertical, V-type, and semi-radial designs . . . single or two-stage units with cylinder sizes from 3" to 13½". Four different frame types accommodate a power range of 50 to 400 HP.

For the most efficient compressor for your needs, consult a Joy Engineer or write to ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



Joy WNB-112 Gas Compressor. Inlet pressure 35 psia; Discharge pressure 665 psia. Capacity .85 MMCFD. "Packaged" by Oil & Gas Supply Company, Houston.



This photo of a Joy WNB-114 Gas Compressor Package being unloaded onto concrete pad clearly illustrates portability of unit. Inlet pressure is 5 psig; Discharge pressure is 150 psig. Capacity 2 MMCFD. "Packaged" by McNamar Boiler & Tank Co., Tulsa.

Write for FREE Bulletin 84-31

Consult a Joy Engineer

FOR PORTABLE ROTARY DRILLS, AIR COMPRESSORS, GAS GATHERING COMPRESSORS, PORTABLE LIGHTING LINES

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JOY

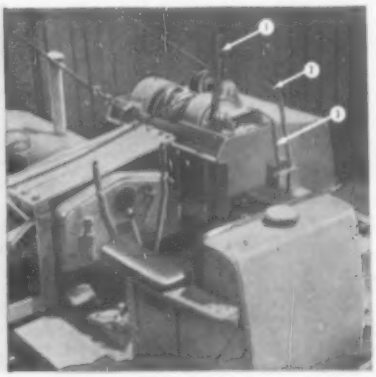
SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

OLIVER OC-12

with new ALL-HYDRAULIC side boom

Just 2 controls *make pipe handling easier, faster, more precise*

Close-up of the Model 12 "Boomer" from operator's platform shows the simple controls for all-hydraulic side boom. ❶ . . Load line clutch, ❷ . . Load line control, ❸ . . Boom line control.



When you see the Model 12 "Boomer" in action, you'll say, "*This is it!*"

Designed specifically for pipeline work, the Model 12 "Boomer" gives you smooth all-hydraulic operation with only *two simple controls*—makes the average operator a real expert in no time. Makes him a *safer* operator, too, because there's no chance of clutch failures at crucial moments.

Equipped with 12' boom, the Model 12 gives you lifting capacity up to 13,375 lb. with easy and accurate control of cable speeds.

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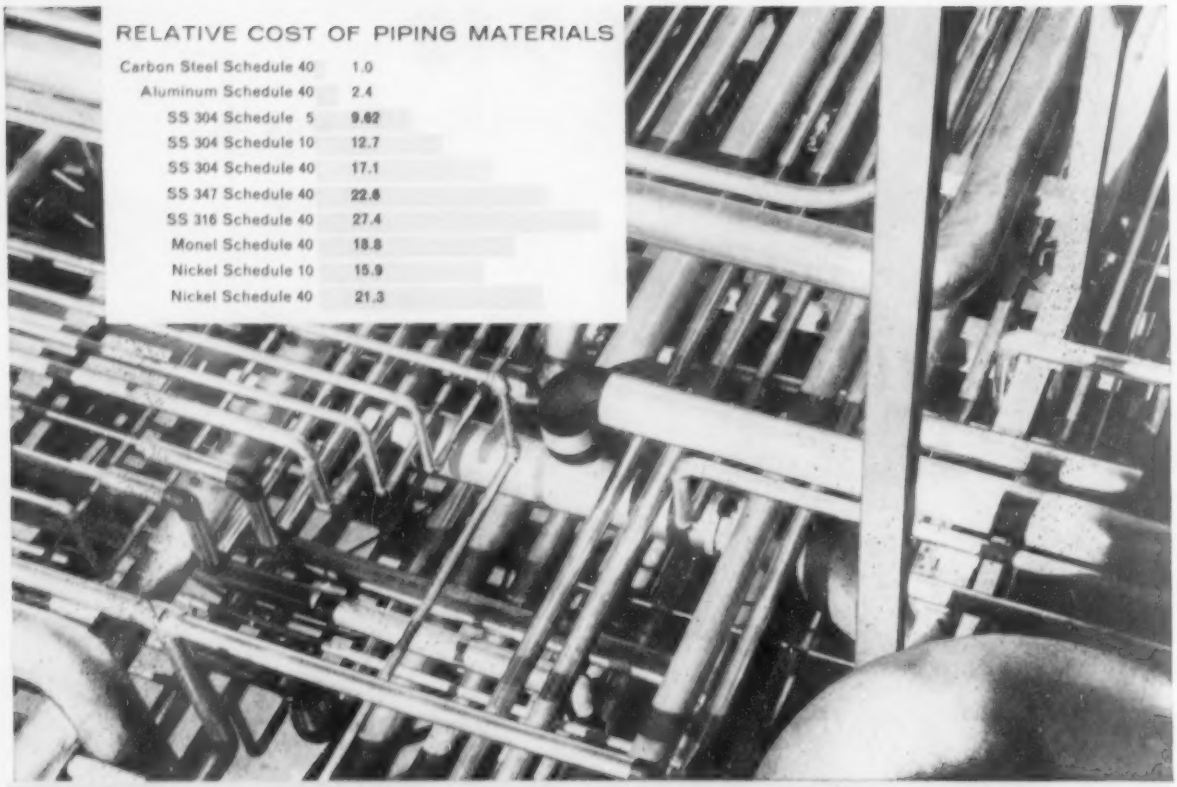


RELATIVE COST OF PIPING MATERIALS	
Carbon Steel Schedule 40	1.0
Aluminum Schedule 40	2.4
SS 304 Schedule 5	9.62
SS 304 Schedule 10	12.7
SS 304 Schedule 40	17.1
SS 347 Schedule 40	22.6
SS 316 Schedule 40	27.4
Monel Schedule 40	18.8
Nickel Schedule 10	15.9
Nickel Schedule 40	21.3

Corrosion Resistant

REYNOLDS ALUMINUM PROCESS PIPE

. . . the pipe that lowers costs

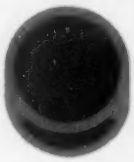
Many of the largest chemical and petroleum processors use a lot of aluminum pipe. They call it the most economical corrosion resistant piping product available.

That's important. Aluminum resists corrosive effects of chemicals like hydrogen peroxide, nitrogen solutions, many acids, alcohols, foods . . . and petroleum products like sweet and sour crudes, raw or refined gases, kerosene, gasoline, naphthas.

And aluminum pipe possesses other advantages. Light weight and easy weldability make for low-cost installation . . . it's nonsparking—assures safety . . . smooth inner surface reduces friction.

Standard Aluminum Fittings are available from leading manufacturers. For more information on how you can save with Aluminum Process Pipe, consult the nearest Reynolds Office listed under "Aluminum" in classified telephone directories, or write to *Reynolds Metals Company, P.O. Box 1800-CR, Louisville 1, Kentucky.*

Write for new brochure "Reynolds Aluminum Process Pipe"



REYNOLDS NEW DUPLEX TUBE for steam traced piping. It does away with cost of external steam jackets or steam tracer tubes—the steam line is part of the aluminum pipe. Saves labor costs, material costs, insulation costs.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

Watch for Reynolds new program, "Circus Boy", Sundays on NBC-TV

New POWER ... TIME-PROVED JOHN DEERE ECONOMY

Top: HANDYMAN "420" CRAWLER . . . 25 drawbar h.p. . . 4- and 5-roller sizes . . . little giant in work capacity. Shown with backhoe, one of its many matching tools.

Above: HANDYMAN "420" UTILITY . . . the low-built, highly maneuverable wheel-type tractor for all-around work. Three-point hitch regular. Shown with front-end dozer.

Everywhere . . . on all types of work . . . John Deere "40" Series Crawler and Wheel-Type Tractors have been making good with contractors, municipalities, and industrial users.

Now, the new "420" Series Tractors, *with 20 per cent more power,* offer you even better performance, even lower costs per job.

Here is the compact, rugged construction, the dependable day-in-and-day-out performance that enables you to get more work done in a given period.

Here is the all-around economy—fuel economy . . . oil economy . . . maintenance economy that sets new high standards—economy that means real dollars-and-cents savings, more profit each year of the tractor's long life.

Here is wide, all-around adaptability to jobs of all kinds, with a great matching line of John Deere and allied working equipment.

There is a John Deere dealer near you. Ask to see the new John Deere "420" Tractors.

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Industrial TRACTORS and Equipment

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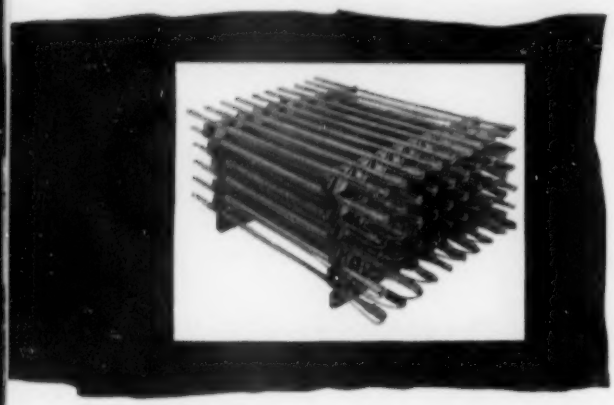
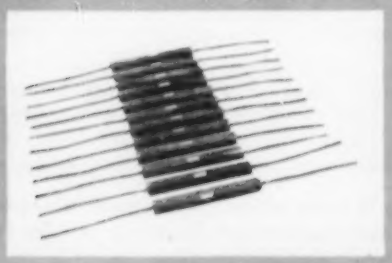
Address _____

City _____ *State* _____

When Duriron was first introduced as a cathodic protection medium, performance data reported was necessarily that of simulated field conditions in the laboratory. Now, with installations numbering more than 15,000 anodes, we can report qualitatively on Duriron in various ground bed, fresh water or salt water conditions.



Many of these reports are available now. More are currently in preparation for early release. If you feel that your present method of protection could be improved, we urge you to let us send you these reports as they become available. They more than confirm our reports of laboratory results!



Qualitative reports now available on DURIRON® in cathodic protection service

THE DURIRON COMPANY, INC.
Dayton, Ohio

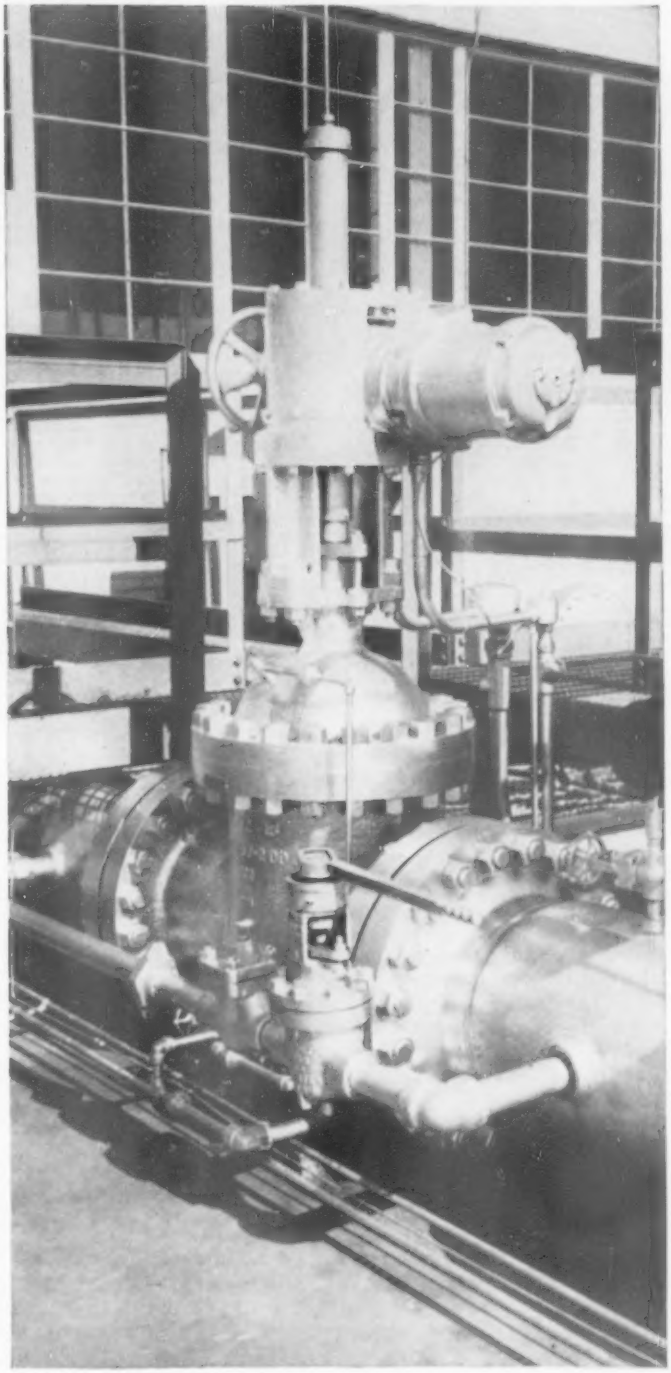
DURIRON® anodes

The Duriron Company, Inc., Dayton, Ohio, Dept P.

PLEASE SEND REPORTS ON DURIRON ANODE INSTALLATIONS.

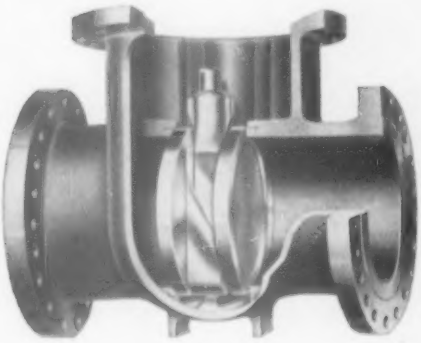
Name_____ Title_____ Company_____

Address_____ City_____ State_____



DARLING

fully-revolving double disc
pipe line gate valve



IDEAL FOR EFFICIENT CONTROL

Here's why

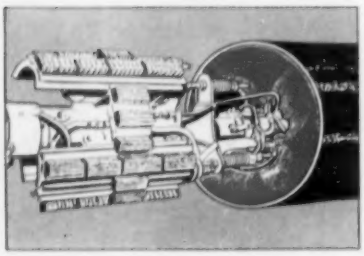
Operation is *consistently* trouble-free! Minimum friction, easy opening and closing, with self adjustment for positive closure. Wedging principle automatically compensates for any body deflection. Fully revolving discs avoid wear concentration. Discs and seats wipe clean with each operating cycle. In short . . . prolonged high efficiency with an extreme minimum of attention. It will pay you to give us an idea of your service needs and get specific details.

DARLING VALVE & MANUFACTURING CO.

Williamsport 1, Penna.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

Copon internal pipe coating selected again by major gas transmission company



Thirty and thirty-six inch pipe being automatically spray-painted at mill following unique metal cleaning process.

Proof of COPON'S effectiveness in solving internal pipe coating problems lies in its growing acceptance by major gas transmission companies. This year it's being used again by one leading firm for new 30" and 36" pipeline construction in addition to many other projects.

COPON internal pipe coatings offer *even more* than outstanding protection against corrosion losses. They *pay off* in protection during storage, lowered maintenance expense and greatly reduced pigging costs. And COPON coatings make possible delivery of cleaner, rust-free gas products.

Scientifically developed systems are available for coating dehydrated gas lines, crude and petroleum product lines, salt water lines, fresh water lines, and oil well tubing and casing. Write your nearest COPON manufacturer today. He will be happy to show you how COPON can be efficiently applied to new pipe, used pipe or pipe-in-ground.

Get complete information about COPON today.

OGJ-9

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Please send me information about COPON Internal Pipe Coatings.

Name_____

Company_____

Position_____

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P. O. Box 1113, Houston 1, Texas

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HANNA PAINT CO., INC.
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KOHLER-McLISTER PAINT CO.
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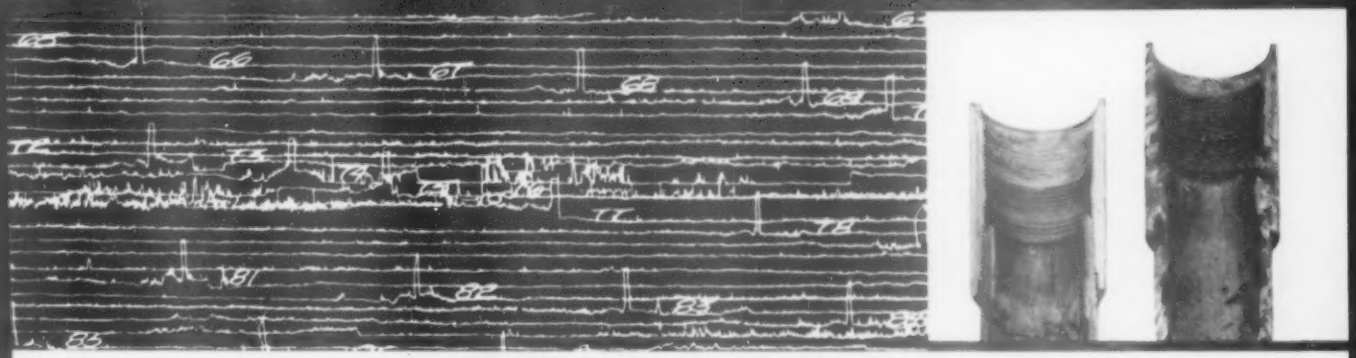
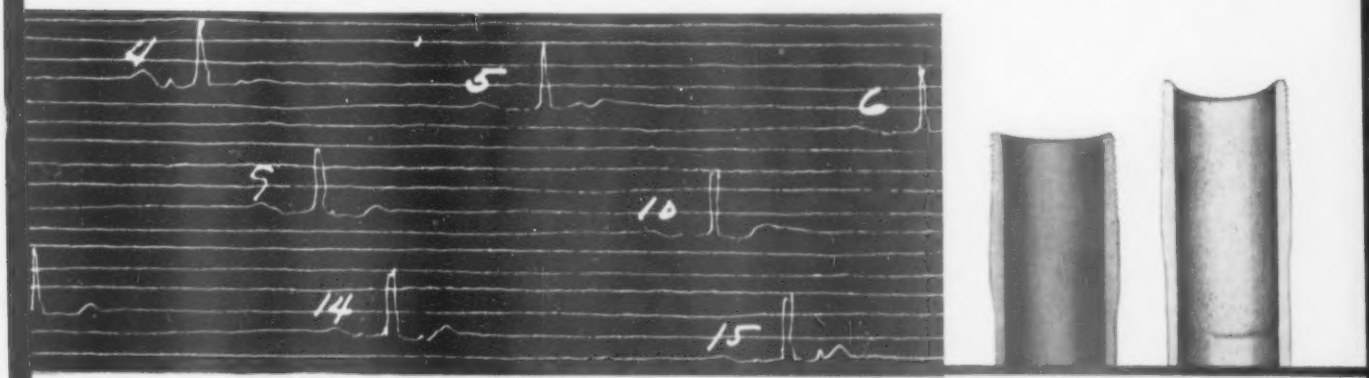
JAMES B. SIPE and COMPANY, INC.
P. O. Box 3010, Pittsburgh 16, Pa.



A caliper survey was made to detect corrosion of oil-well tubing. Erratic "blips" on the survey chart indicate corrosion in well using ordinary inhibitor. Parts of two corroded tubes are shown at right.



Evenly spaced "blips" in this chart show no corrosion, merely indicate tubing joints in well using inhibitor containing Sunaptic acid. The tubes look like new. Both surveys taken after one year.

KING-SIZE ACID MOLECULE DOUBLES EFFICIENCY OF CORROSION INHIBITOR

Any product you're now making with fatty, rosin, synthetic or ordinary naphthenic acids stands a good chance of improvement with Sunaptic acids

In the above test, the substitution of high-molecular-weight Sunaptic® acid for fatty, rosin, synthetic and ordinary naphthenic acids proved to be the prime reason for improving the corrosion inhibitor.

During a year of testing, the Sunaptic acid type corrosion inhibitor completely eliminated service jobs due to corrosion. In a similar period, rust and corrosion resulted in nine service jobs while using an ordinary corrosion inhibitor.

Other unusual properties: no olefinic unsaturation, high resistance to oxidative rancidity, low freezing or pour points, and a higher hydrocarbon solubility than ordinary naphthenic, fatty and rosin acids.

Typical applications of Sunaptic acid derivatives include anti-oxidants, oil-soluble detergents, lubricant additives and plasticizers.

For free literature on Sunaptic acids and their uses, see your Sun representative, or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. O G - 9,

For information about where you may obtain oil-well corrosion inhibitors fortified with Sunaptic acid, write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. O G - 9.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY PHILA. 3, PA.

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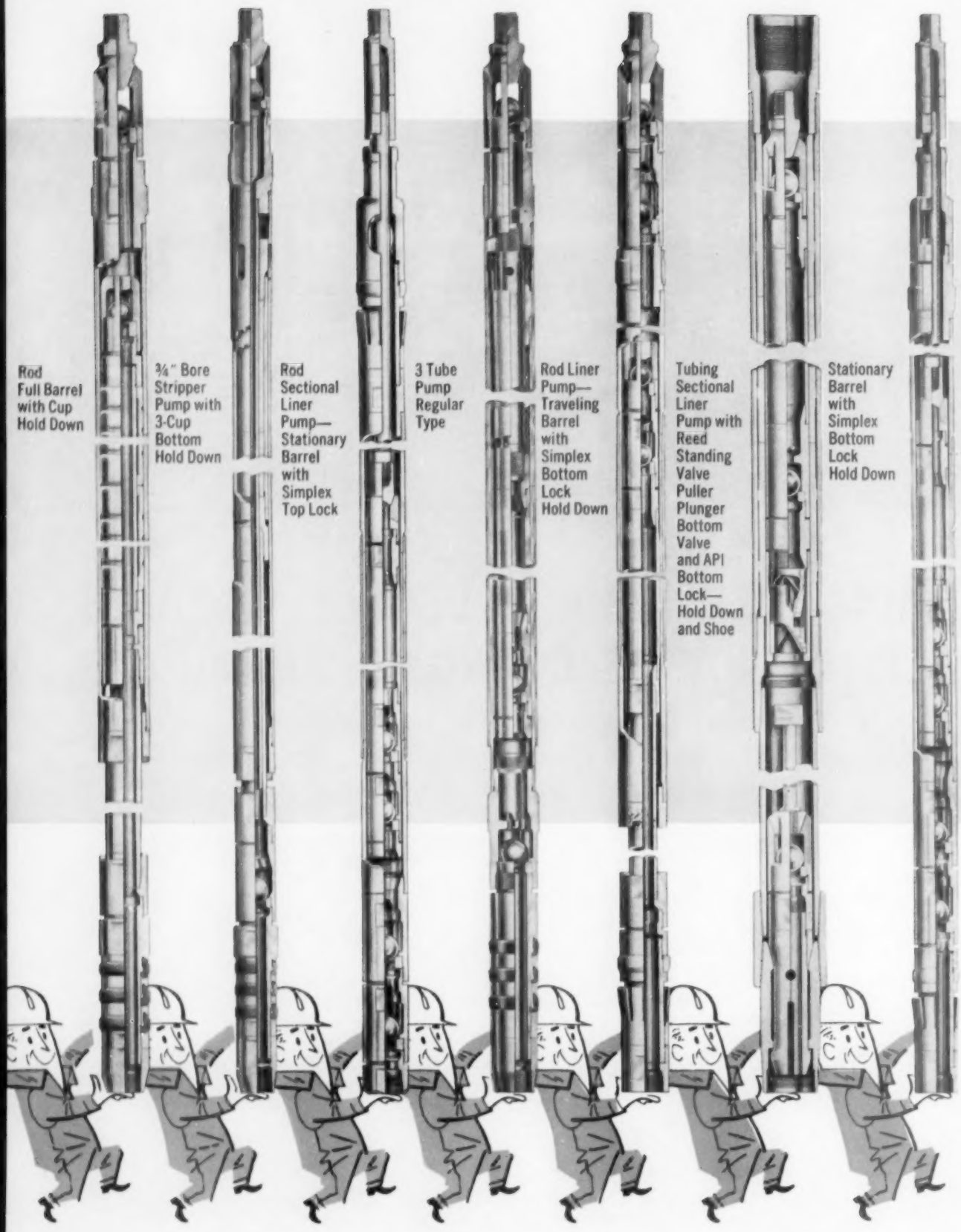
SUNOCO


Rod
Full Barrel
with Cup
Hold Down
¾" Bore
Stripper
Pump with
3-Cup
Bottom
Hold Down
Rod
Sectional
Liner
Pump—
Stationary
Barrel
with
Simplex
Top Lock
3 Tube
Pump
Regular
Type
Rod Liner
Pump—
Traveling
Barrel
with
Simplex
Bottom
Lock
Hold Down
Tubing
Sectional
Liner
Pump with
Reed
Standing
Valve
Puller
Plunger
Bottom
Valve
and API
Bottom
Lock—
Hold Down
and Shoe
Stationary
Barrel
with
Simplex
Bottom
Lock
Hold Down

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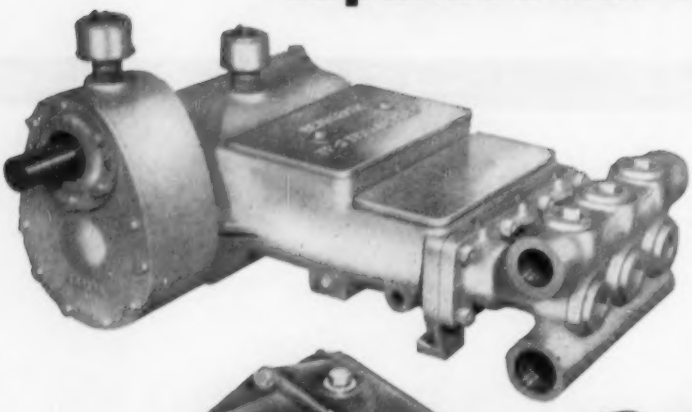
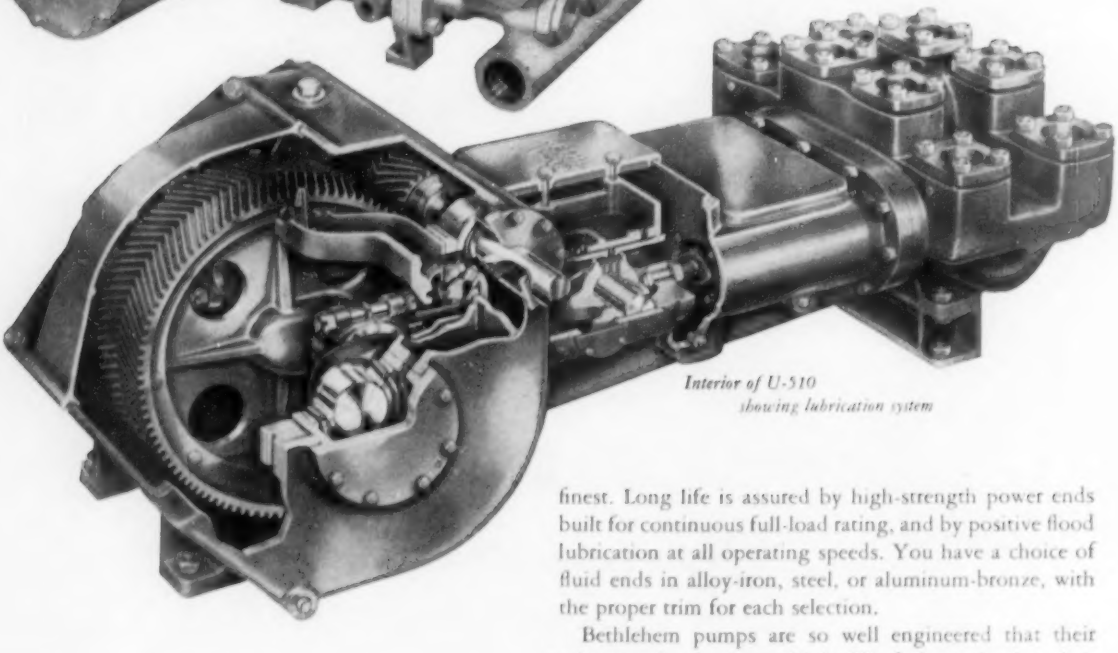
P-603

Pick your "Handy Man" from this expanded line of power pumps



TP-3 Triplex Pump



Interior of U-510 showing lubrication system

Bethlehem now offers five distinct sizes of general-service pumps, so that it's even easier to pick just the right unit. We doubt that you've ever seen a line of pumps with so much versatility. Each is a "handy man"—a pump that can readily be adapted for several different kinds of work.

Does your job involve waterflooding? Salt-water disposal? Pumping crude oil in gathering systems or pipe-line service? Pumping mud or water for the drilling rig? If the answer is yes, there are Bethlehem units that will fit perfectly into your engineering plans.

You can bank completely on the quality of these pumps. Components are exhaustively tested. Materials are the finest. Long life is assured by high-strength power ends built for continuous full-load rating, and by positive flood lubrication at all operating speeds. You have a choice of fluid ends in alloy-iron, steel, or aluminum-bronze, with the proper trim for each selection.

Bethlehem pumps are so well engineered that their salvage value is always high. We feel certain that their many advanced features will interest you. If you will write or call, our people will gladly furnish complete information.

FIVE SIZES, DUPLEX AND TRIPLEX

Model	Type	Plunger Load, lb	Input Hp	Bore & Stroke, in.
U-33	Duplex	2400	14 @ 180 rpm	1¾ to 3 x 3
UA-46	Duplex	5000	40 @ 120 "	2½ to 4 x 6
U-510	Duplex	12000	100 @ 75 "	3 to 5½ x 10
TP-3	Triplex	3580	22.4 @ 250 "	1¾ to 2¾ x 3
TP-4	Triplex	5000	42 @ 250 "	2 to 4 x 4

BETHLEHEM SUPPLY COMPANY

General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.
Export Distributor: Bethlehem Steel Export Corporation
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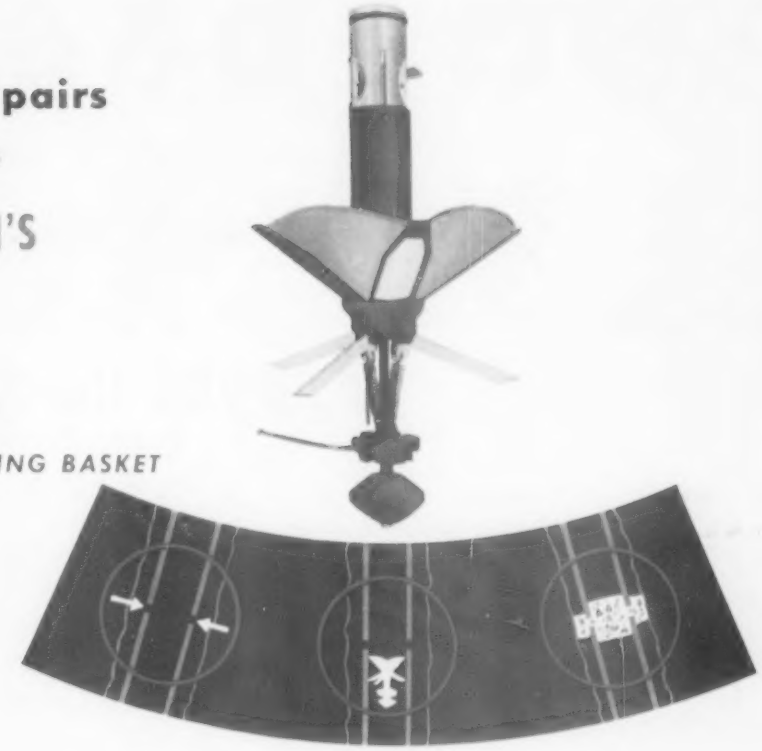
BETHLEHEM SUPPLY

isolates and repairs in one fast trip

HALLIBURTON'S DUMP BAILER SERVICE

with "DB" BRIDGING BASKET



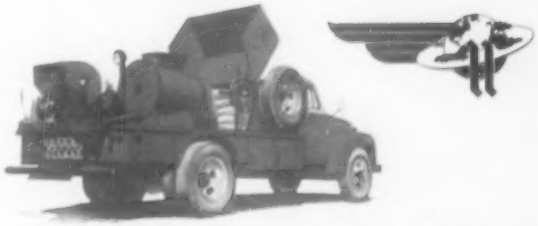
Nobody realizes more keenly than Halliburton that saving down-time on remedial jobs is saving you important money. And that's why Halliburton's Dump Bailer Service uses the "DB" Bridging Basket as an efficient "time saver" for isolating formations, plugging back and repairing casing leaks.

SETTING AND DUMPING ARE SIMULTANEOUS

Setting the drillable "DB" Bridging Basket is as simple as opening an umbrella. A light pick-up on the bailer permits well fluid to open the basket and hold it at the desired depth as bailer and adapter are pulled away from the Bridging Basket. The four setting legs are released into the side of the open hole or casing at the same time the bailer is pulled away. As the setting legs spring out, the upper body of the Bridging Basket is freed from the bailer adapter. The Bailer bottom is also opened by this action, allowing the cementing materials to fall into the basket as the bailer is retrieved. This single, synchronized action can save one or more costly round trips for building temporary or permanent plugs in casing or open hole.

A MONEY-SAVING SERVICE

Unnecessary delays that once required large workover units and costly rig-time have been greatly reduced by Halliburton's unmatched combination of equipment, men, materials and Dump Bailer technique. For dependable, experienced service ask any Halliburton representative or call your nearest local or district office of the Halliburton Oil Well Cementing Company, Duncan, Oklahoma.



COMPLETE DATA SENT ON REQUEST

Get this valuable information for your Halliburton Service File

HALLIBURTON CEMENTING SERVICES

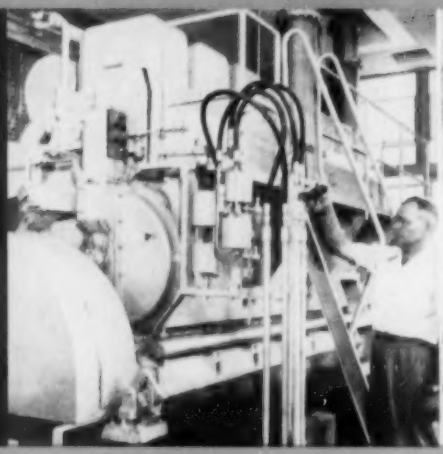
251 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

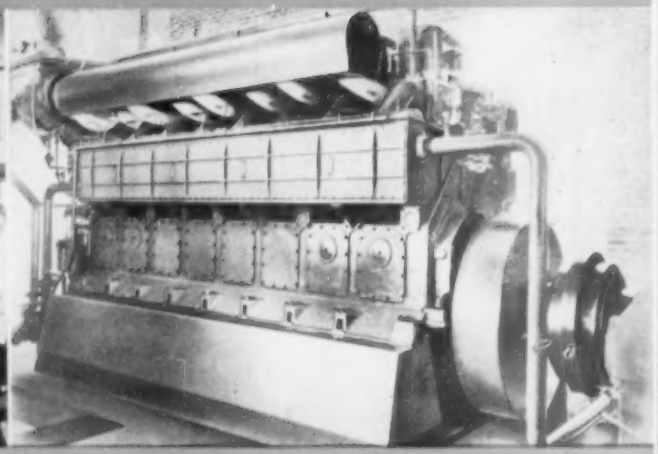
NORDBERG ENGINES

Provide Low Pipe Line Transportation Costs ACROSS the Continent

• Each year there are more and more Nordberg engines installed by pipe lines. The reasons are sound . . . these compact, more powerful engines efficiently meet the operator's requirements for all types of pumping.

NORDBERG POWER ON THE JOB:



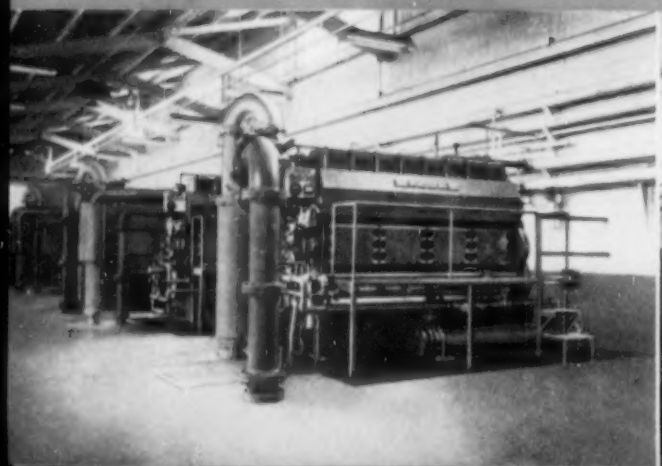


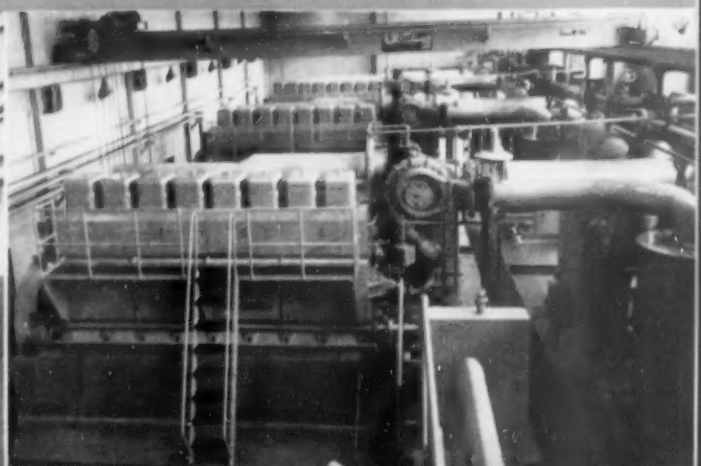
• One of two Nordberg eight cylinder, 1210 hp Supercharged Diesels on Shell Oil Company's Wood River products pipe line.

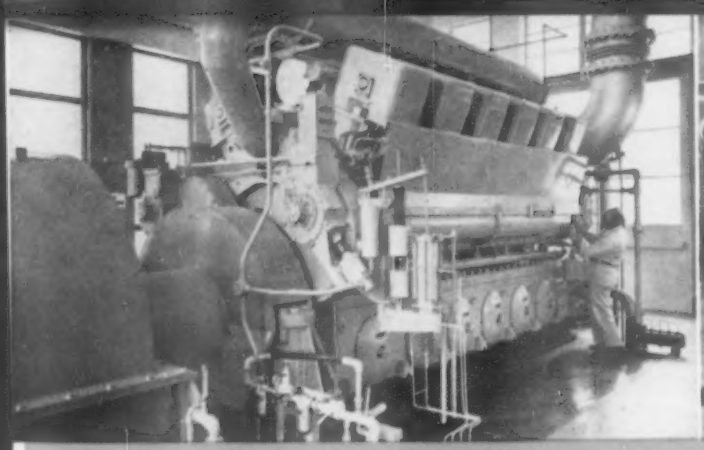
• Four of the 23 Nordberg engines installed in stations along the Rangeley, Colo.-Salt Lake City crude and products lines operated by Salt Lake Pipe Line Company.

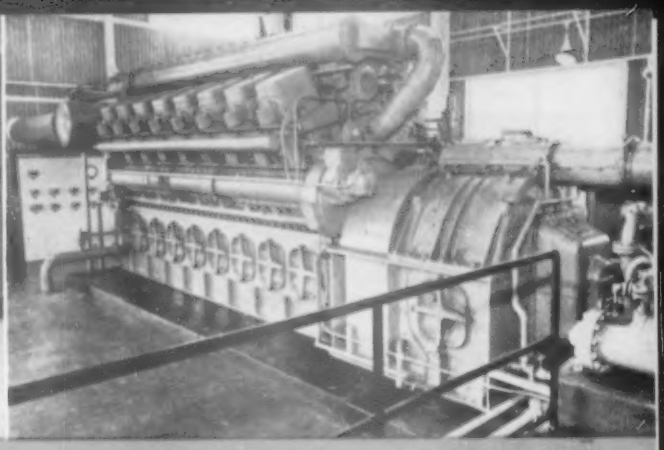
• One of nine Nordberg eight cylinder, 13" bore SUPAIR-THERMAL® Dualfuel engines operating on a Phillips Pipe Line Company products line.

• Twelve of these Nordberg SUPAIRTHERMAL engines provide a total of 22,680 hp for pumping stations along the Lakehead Pipe Line Company's line.







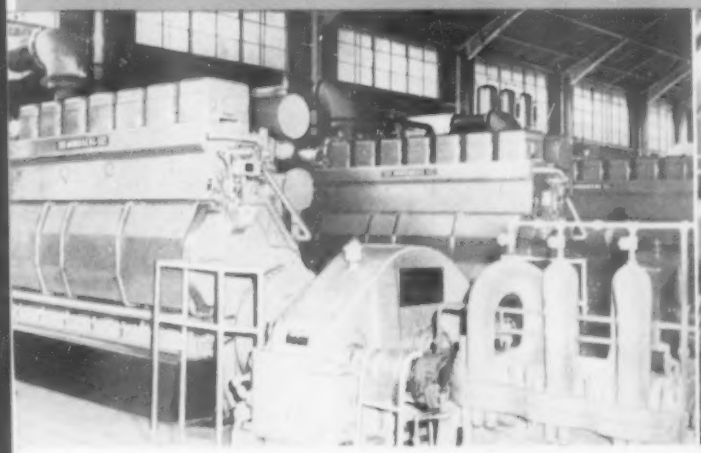


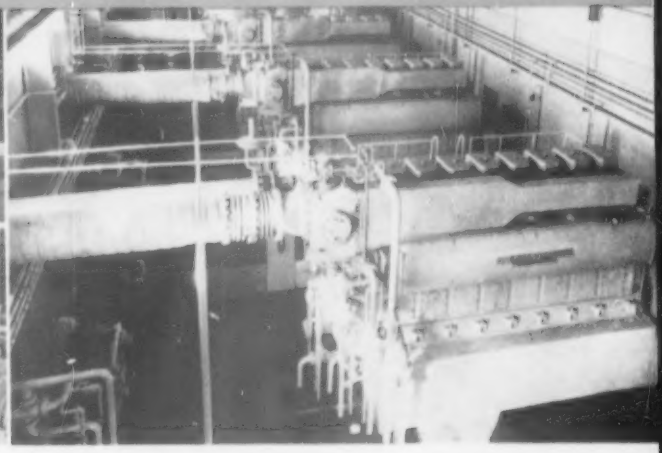
• Nordberg 2650 hp automatically-controlled SUPAIRTHERMAL V-type Diesel furnishes all power for the Vicksburg, Mich., station on the Wolverine Pipe Line Company's products line.

• Three of six Nordberg 1050 hp Duafuel engines installed in the Tejon and Wheeler Ridge stations of Richfield Oil Corporation's crude oil pipe line.

• 3000 hp Nordberg V-type SUPAIRTHERMAL Spark-Ignition Engine Gear Set driving a centrifugal gas compressor in Transcontinental Gas Pipe Line Corporation's Station 23 near Houston, Texas.

• Three of 12 Nordberg SUPAIRTHERMAL engines, totalling, over 20,000 hp, installed along the Trans Mountain Pipe Line from Edmonton, Alta., to Vancouver, B.C.





SUPAIRTHERMAL® ENGINES

the logical choice for these basic power jobs:

- PIPE LINE PUMPING
- GAS COMPRESSOR DRIVE
- POWER GENERATION

Nordberg four-cycle Supairthermal engines are available in a full range of sizes from 535 to 5000 hp for Diesel, Duafuel® or Spark-Ignition Gas operation, including both In-line and "V" types. The Supairthermal principle increases the engine's load-carrying ability over a wide speed range. This reserve power is like "money in the bank" when additional capacity is needed. We welcome your inquiry and the opportunity to assist you with your power study.

NORDBERG MFG. CO., Milwaukee, Wis.

Builders of America's Largest Line of Heavy Duty Engines—10 to over 12,000 Horsepower

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

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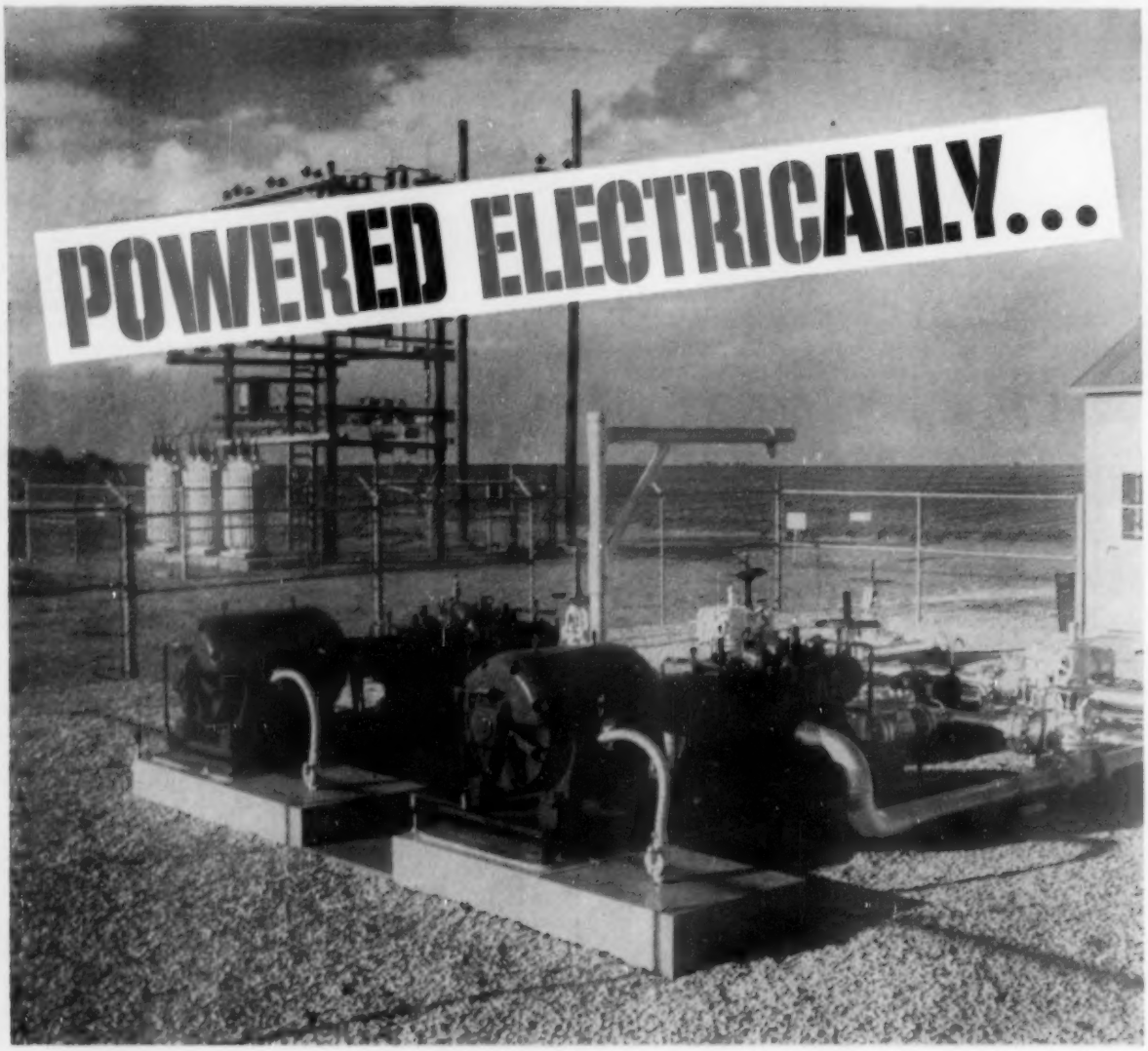

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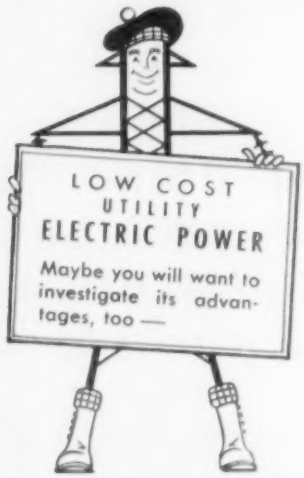
Whenever Low Cost Utility Electric Power is on the job ... you'll readily see the difference. Electric Power offers the operator a cleaner power source with the added advantages of LESS MAINTENANCE, LESS ATTENTION, and LESS MANPOWER. Automatic Remote Controls also mean greater efficiency... plus a more economical operation. Be sure of power when and where you need it... but be sure its Low Cost Utility Electric Power.



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● Manufacturing ●● Manufacturing and product development ●●● Manufacturing, product development and research □●● Pilot manufacturing, product development and research

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	GPE CAPACITIES
●●●	●●	●●	□●●	●●	●●●		●●	●●●	●●	●●	●●	●●●	Precision Mechanics, Optical Devices, Ceramics
●●●	●	●			●●●		●●●	●●	●	●●	●	●●●	Electrical Equipment and Components
●●●	●●	●●●	●●●		●●●		●	●●		●●●	●●	●●●	Electronics
	●●			●●●		●●●				●●●			Hydraulics, Liquids Processing, Heat Exchange
●	●		●●●		●					●			Television: Studio, Theatre, Business, Institutional, Industrial
●●●	●	●●	□●●		●●●	●●●	●●	●●		●●●	●	●●●	Instruments, Servos, Controls: Hydraulic, Pneumatic, Magnetic, Electronic
●●●	●		●●●		●●●		●			●●	●	●●●	Aircraft and Missile Guidance, Control, Simulation
●●●	●	●	□●●		●●●					●●●		●●●	Automatic Computers and Components
●●●	●	●●	●●●		●●			●		●			Radar, Microwave, Ultrasonics
	●●●		□●●				●●	●●●	●●●		●●●		Motion Picture and Audio Equipment
●●●				●●						●●		●●●	Nuclear Power Components and Controls
●●●			●●●	●●●	●●●	●●●				●●●		●●●	SYSTEMS ENGINEERING

Librascope Desk-Size Computer

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GPE SYSTEMS ENGINEERING

The GPE Companies are leaders in that small, select group in American industry which is broadly qualified to develop and produce the systems needed today for defense and industry. GPE leadership accounts for some of the most advanced systems in use in business, television, aviation, marine, steel, oil, and other industrial fields.

In Systems Engineering, highly advanced capacities and resources are prerequisite. Yet, no matter how highly advanced, they are of little use if limited to a few areas. Finding optimum solutions to complex systems problems calls for *balanced competences*. And beyond that, success calls for the consistent application of such competences *at every stage* — beginning with research, and extending all the way through development, production and final testing.

No GPE company is limited by the boundaries of its own specialties. The basic GPE operating policy, GPE Coordinated Precision Technology, places at the command of each company in the group all GPE research, development and production facilities, and the skills and experience of the more than 2500 GPE technical men working in depth in the wide range of advanced capacities indicated in the chart above.

Behind each group working on a specific problem in one GPE company stands the whole group of GPE scientists, engineers and technicians with the answers — or the knowledge that will find the answers — to questions underlying and related to that problem. To the customers of GPE Companies this means that the concept and development of equipment, components and systems are not restricted or distorted by traditional allegiance to specific competences.

The five systems illustrated, while products of different GPE companies, are all examples of the consistent application of balanced competences, achieved through GPE coordination. For brochure describing GPE Coordinated Precision Technology and the work of the GPE Companies, or help on a specific problem, write: General Precision Equipment Corporation, 92 Gold Street, New York 38, N. Y.

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(IV) GENERAL PRECISION LABORATORY INCORPORATED (V) THE GRISCOM-RUSSELL COMPANY (VI) LINK AVIATION, INC.
(VII) SHAND AND JURS CO. (VIII) THE HERTNER ELECTRIC COMPANY (IX) THE STRONG ELECTRIC CORPORATION
(X) J. E. McAULEY MFG. CO. (XI) ASKANIA REGULATOR COMPANY (XII) AMPRO CORPORATION (XIII) LIBRASCOPE, INCORPORATED

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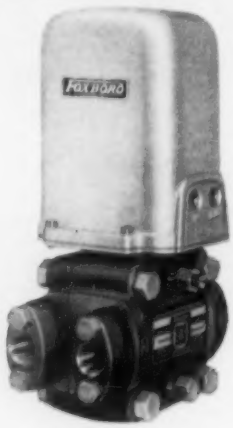
. . . with Foxboro Instrumentation

Differential Pressure Cell Transmitters

Complete line includes air-operated and electric-operated d/p Cell Transmitters covering ranges from 0-20" to 0-800" of water; working pressures up to 1500 psi.

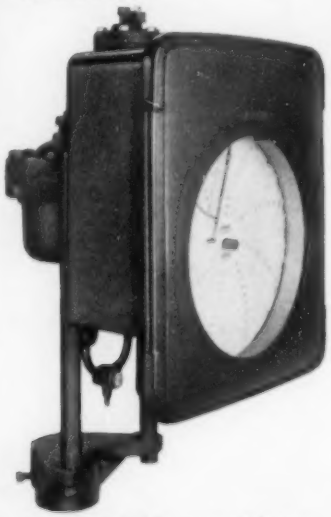


Type 13A d/p Cell Transmitter

- Positive Overrange Protection—up to full 1500 lb. rating
- Fully Adjustable Ranges—0-20" to 0-80" and 0-50" to 0-250" water
- Automatic Internal Damping — fast, stable measurement
- Simplicity—easiest, lowest-cost installation, lowest maintenance

Mercury Type Meters

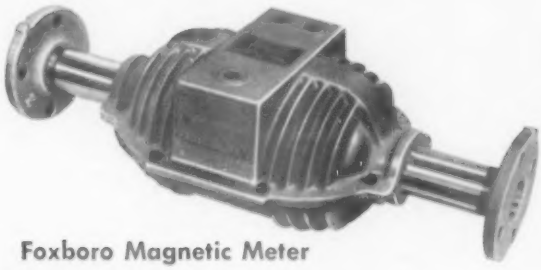
Complete line includes mercury types covering ranges from 2 to 400" of water; working pressures up to 5000 psi.



Type 28 Mercury Meter

- Permanent Full-Scale Meter Accuracy — exclusive segmental lever design provides linear transmission from float to pen
- Highest-Powered Pen Drive — large float with long travel
- Minimum Ambient Temperature Effects — float located in high pressure chamber

PROBLEM



Foxboro Magnetic Meter

- Measures Fluid Velocity Directly
- Adds No Pressure Drop
- Uniform Flow Scale
- Overall Accuracy Better than 1% of Range Over Entire Scale
- Full Accuracy Sustained Even on Liquids Other Meters Can't Handle — even sand and water slurries

THERE ARE two logical reasons why Foxboro Instrumentation assures you *optimum* results in measurement or control of process fluid streams. First; Foxboro offers the widest variety of measuring and controlling devices . . . the *right* equipment for every application. For example, only Foxboro offers all these basic meter types: differential pressure cell flow transmitters, magnetic meters, mercury meters, and weir meters. Second; Foxboro provides 45 years of engineering experience in every phase of fluid mechanics. From the simplest general utility-type instrument to complex automatic ratio control systems, you get highest accuracy, efficiency, and economy. Whenever you have a flow problem involving liquids, vapors, gases, or slurries — in pipes, ducts, or channels, you can solve it best by specifying Foxboro. Only a few instruments are described on these pages. For full details; or for specific information on *your* problem, contact your nearby Foxboro Field Engineer, or write **The Foxboro Company, 609 Neponset Ave., Foxboro, Mass.**

FOXBORO
REG. U. S. PAT. OFF.

FIRST IN FLOW

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Float-and-Cable Type Meters

- Rigid Construction — weather-tight case; all working parts of corrosion-resistant materials
- Powerful Accurate Operation — large, high-stability float; cable of Type 302 Stainless Steel — non-stretching, non-twisting
- Direct Reading Chart and Scale
- Direct Reading Integral Counter

Other Foxboro Flow Instrumentation

Electric or Pneumatic Type Rotameters

Electric, Pneumatic, and Mechanical Integrators

Planimeters

All Primary Elements, Valves, and Accessories required for assembly of complete flow measurement and control systems

Now *from INTERNATIONAL...*

New "all-purpose" light-duty 4-wheel-drive truck!

Here's the four-wheel-drive truck you've been waiting for! Here's a full-size, all-purpose truck you can use to go anywhere.

On or off the road, this new INTERNATIONAL S-120 (4x4) will take the toughest grades in stride—fully loaded, it will move entire 7,000 lbs. of truck, body and cargo through soft sand, mud or snow. It's made to match all light-duty 4x4 jobs *exactly* with choice of 2 engines, 3 pickup, 2 stake and platform bodies, and the 8-passenger, triple-duty Travelall.® Exclusive INTERNATIONAL full-torque power take-off transfer case available, plus power take-off transmissions for auxiliary equipment operation. Available in 6 tire sizes, including 7.00 x 18 for extra clearance and 9.00 x 16 for extra flotation and traction.

This new INTERNATIONAL is all truck-built for rough, tough four-wheel-drive service . . . built to save you the BIG money, the operation and maintenance money. Before you buy any light-duty four-wheel-drive truck, see and drive this one at your INTERNATIONAL Dealer or Branch!

INTERNATIONAL HARVESTER COMPANY • CHICAGO

A Complete Line of All-Wheel-Drive Trucks for Every Tough Job Need

S-140 (4x4). 11,000 lbs. GVW. Has 4-speed transmission and 2-speed transfer case, for 8 forward and 2 reverse speeds.

Bigger models, too. S-160 (4x4) Series, 15,000-18,000 lbs. GVW. SF-170 (6x6) Series, to 26,000 lbs. GVW. All have exclusive INTERNATIONAL full-size Comfo-Vision cabs . . . feature easiest steering and handling.

INTERNATIONAL® TRUCKS

All-Truck Built to save you the BIG money!

Motor Trucks • Crawler Tractors • Construction Equipment • McCormick® Farm Equipment and Farmall® Tractors

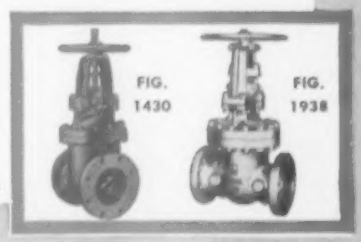
LUNKENHEIMER OPENS

New Modern IRON and STEEL VALVE PLANT

THIS 400-foot machine bay—one wing of the new Lunkenheimer plant—houses the industry's most up-to-date precision equipment for manufacturing iron and steel valves.

Here, old-world craftsmanship and attention to detail—a Lunkenheimer tradition since 1862—are combined with modern production facilities to assure the highest standards of quality. Lunkenheimer Iron and Steel Valves are world-famous for long life and low maintenance. Their shoulderless seat rings will not warp, and the gates have exclusive machined disc guides that eliminate "chatter" and reduce wear.

This entirely new iron and steel valve plant is located next to the Lunkenheimer bronze plant, which was completely modernized a few years ago in a sweeping $3 million program. Together, they give you the finest, most dependable valves that man can build or money can buy. The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.



L-456-29

STEEL • IRON • BRONZE • PVC

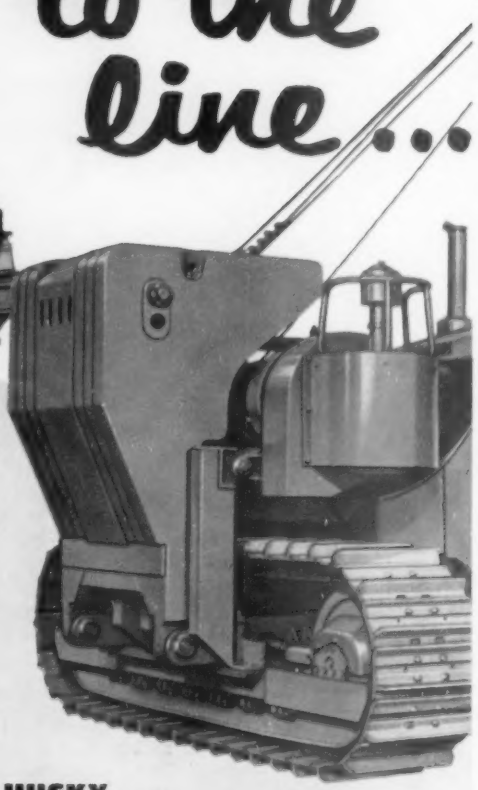
LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

IF YOU'RE PUSHING FOR FASTER PIPE FOOTAGE...

Look...

to the line...



HD-11

90 net engine hp

Weight — 34,134-lb tractor and side boom with full counterweight

40,200-lb lifting capacity at 4-ft overhang

HD-16

150 net engine hp

Weight — 57,840-lb tractor and side boom with full counterweight

77,580-lb lifting capacity at 4-ft overhang

• A SIZE FOR ANY JOB

Big inch or small, there's an Allis-Chalmers tractor-Tractomotive side boom to handle the job. The powerhouse HD-21 has proved itself on 36-in. and bigger pipe. The new HD-16 not only speeds work on medium-size pipe, but has pleased owners with its ability to handle the big pipe as well. The HD-11 handles feeder, distribution and smaller inch jobs . . . is ideal on the big lines for handling pipe sections for welders and bending gangs. This crawler tractor-side boom combination also has wide application for maintenance, repair and take-up on existing lines.

• IN STEP WITH TODAY

Here is a line of tractor-side booms that gives you the latest in design advantages: new Allis-Chalmers diesel engine — new design torque converter drive . . . new long-life track and heavy-duty roller bearing truck wheels . . . new power train with big reserve capacity PLUS all-steel box-A main frame; straddle-mounted final drive gears; 1,000-hour lubrication of truck wheels, idlers and support rollers; oil-enclosed track release mechanism.

High clearances underneath both tractor and counterweight permit moving over obstacles and operating efficiently under roughest conditions.

• SAFE, HUSKY TRACTOMOTIVE SIDE BOOM

Side boom features drop-proof safety counterweights . . . internal expanding brakes, fully enclosed from dirt and moisture . . . easy-working, convenient controls . . . and constant-mesh transmission. Heavy-duty box-section construction gives booms plenty of strength to utilize tractor lifting capacity and handle peak pipe loads.

• GET THE FACTS — FIRSTHAND

See your dealer for full information on the new line of Allis-Chalmers crawler tractor-Tractomotive side boom combinations. It's the line for the big pipe jobs of today — and tomorrow.

ALLIS-CHALMERS

ALLIS-CHALMERS CRAWLER TRACTORS

TRACTOMOTIVE SIDE BOOMS

Pipeliners are known for their eager acceptance of new ideas, techniques and equipment. The result is bigger, better pipe lines at record speeds — in spite of rivers, mountains, deserts and bad weather conditions. And it's this pipeliner desire for better ways of doing things that's putting more and more Allis-Chalmers tractors with Tractomotive side booms on pipe-line spreads all over the world. These units are the most modern, advanced design tractor-side booms a pipeliner can use.

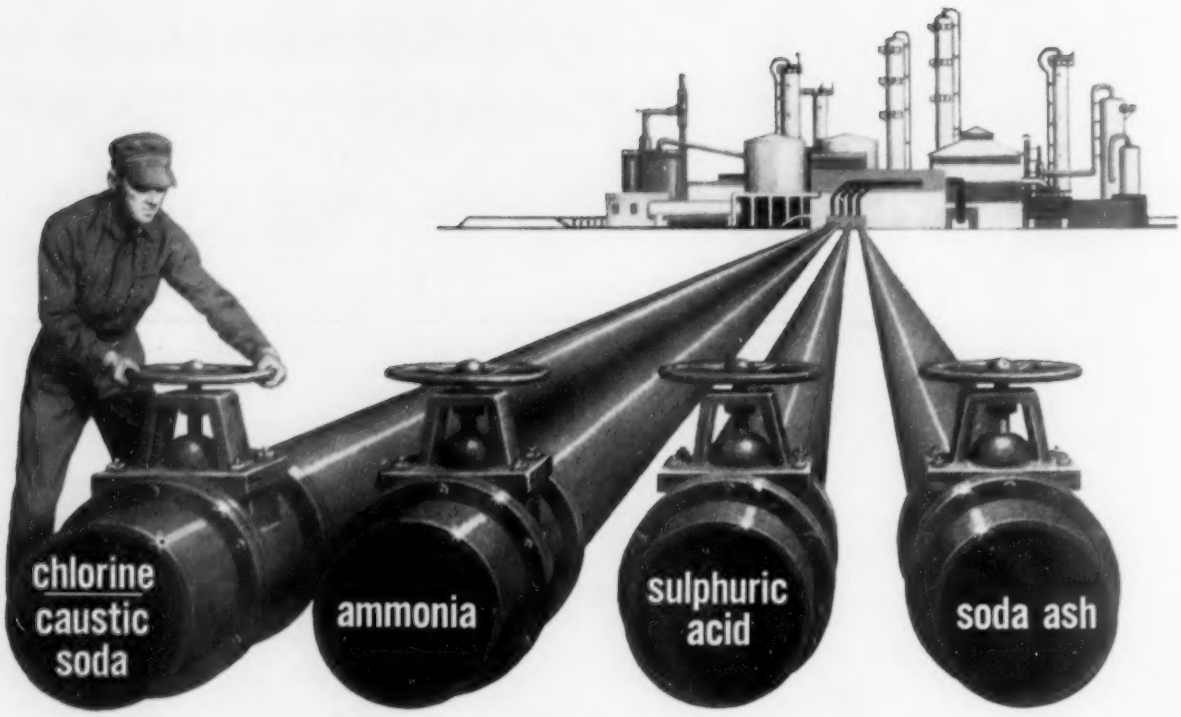
ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

of advanced design

HD-21

204 net engine hp
Weight — 78,250-lb tractor and side boom with full counterweight
127,000-lb lifting capacity at 4-ft overhang

TRACTOMOTIVE CORPORATION
DEERFIELD, ILLINOIS



you can be on our "pipe line"

Want to smooth out your chemical supply problems? Tap into the Olin Mathieson "pipe lines." You'll see what our multi-plant production facilities can mean to you.

The effect of a number of producing points is to balance out local shortages and surpluses. In one instance, a serious chlorine shortage on the Gulf of Mexico was relieved by an excess in Canada. Each of the five plants between shipped into the next plant supply area to the South, setting up a chain reaction which released the needed tonnage on the Gulf.

Our combination of multi-plant facilities and an imaginative approach to the logistics of the chemical industry can prove invaluable to you. Discuss it now with an Olin Mathieson representative or write the Chemicals Executive Office in Baltimore.

MATHIESON

MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION · BALTIMORE 3, MD.

4128

INORGANIC CHEMICALS: Ammonia · Bicarbonate of Soda · Carbon Dioxide · Caustic Potash · Caustic Soda · Chlorine · Hydrazine and Derivatives · Hypochlorite Products · Muriatic Acid · Nitrate of Soda · Nitric Acid · Soda Ash · Sodium Chlorite Products · Sulphate of Alumina · Sulphur (Processed) · Sulphuric Acid
ORGANIC CHEMICALS: Ethylene Oxide · Ethylene Glycols · Polyethylene Glycols · Glycol Ether Solvents · Ethylene Dichloride · Dichloroethylether · Formaldehyde · Methanol · Sodium Methylate · Hexamine · Ethylene Diamine · Polyamines · Ethanolamines · Trichlorobenzene · Polychlorobenzene · Trichlorophenol

Hardened, Honed Seats

for tough throttling service

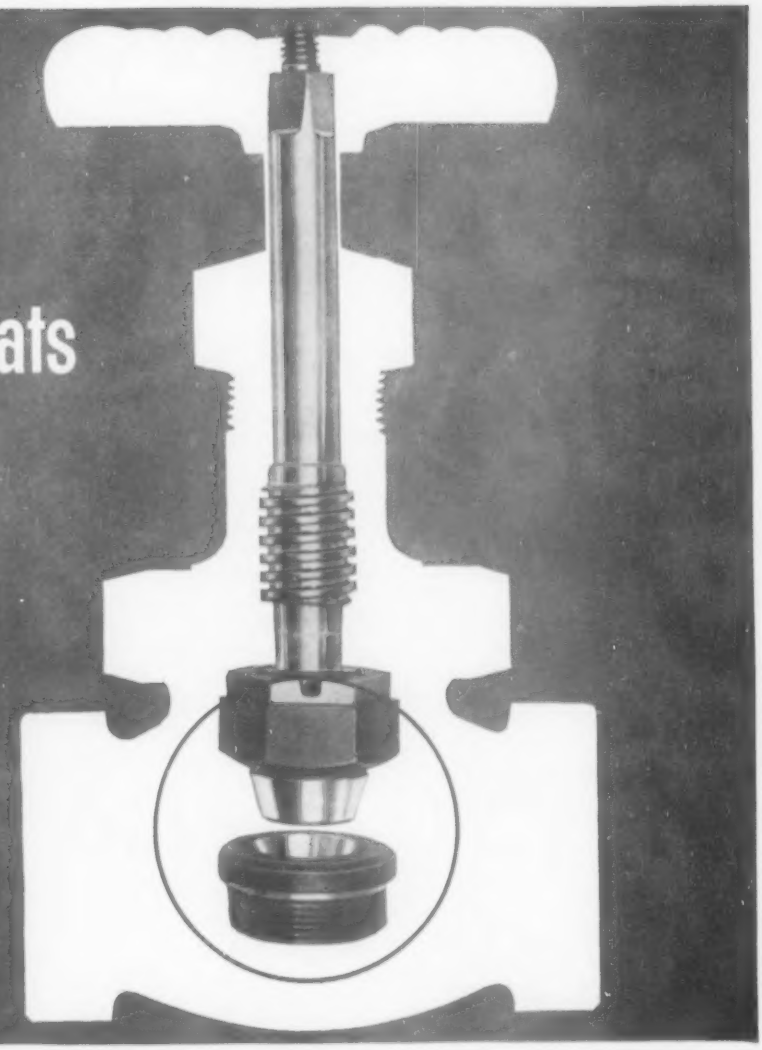


Fig. No. 558, bronze globe valve, 200 lbs. WSP, @ 550°F., 400 lbs. WOG, non-shock

A plug-disc and seat so hard they can crush scale between them and still close tight. A stem that absolutely will not gall or seize. The combination is in a rugged bronze valve designed for tough throttling service . . . the OIC 558!

Both plug-disc and seat are stainless steel, heat-treated to more than 500 Brinell hardness. Their seating surfaces are ground and *honed* to an accurate, smooth, bearing finish. The stem is OIC *alloy-40*, a sturdy bronze which won't gall or seize.

Remember, in throttling service a valve's stem, plug-disc and seat must withstand the most abusive wear. Rely on the toughness designed into this OIC line to give you extra-long service. Specify the modern 558 where you need bronze globe valves for throttling.

Write for Form No. 1001 which describes this valve along with the entire OIC 500 line, including composition disc and spherical disc globes, angles and check valves.

Call your OIC Distributor.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | **FORGED & CAST STEEL, BRONZE & IRON, LUBRICATED PLUG VALVES**

Design Factors in Telemetering Systems

Four important points to consider in planning for remote measurement or recording

A BRISTOL APPLICATION NOTE

Telemetering systems provide a proven way to keep tabs on a remotely located process, pipe line, service or utility. In fact, any time remote indication recording, or control is required, telemetering can serve your needs.

Here are the four conditions which must be considered in selecting the best telemetering system for any installation.

1. VARIABLES

Most industrial variables can now be measured, computed, and converted into a form that can be transmitted electrically. Their number and variety influence circuit complexity and the appearance of the receiving panel. Some variables now being successfully telemetered include:

Pressure • Current and voltage • Temperature • Flow • Electrical power • Wind velocity • Liquid level • Motion • BTU's • pH Horsepower • Speed

2. FREQUENCY OF READING

While the majority of telemeter systems in service today are the point-to-point continuous recording type, complex networks and interrelated variables are making sophisticated approaches more and more necessary. The problem usually boils down to these questions: how often is measurement necessary, and what is the least costly way to install and run the system?

Five types of possible hook-ups are:

Continuous recording—where variables are critical and need constant watch.

Intermittent indicating—where variables need only be checked at intervals.

Continuous-Intermittent—where it is possible to separate more critical variables for constant and intermittent telemetering.

Grouped-Multiplex—where several measurements can be transmitted as a group over a single circuit into a "multiplexed" receiver.

Successive-Multiplex—where measuring points over a large area can be "multiplexed" at intermediate locations, then herded to the panel.

3. TERRAIN

The type of interconnecting circuit between the measuring transmitters and central panel usually depends on the terrain: its topography, weather, and degree of settlement. Hence, signals may be carried by one, or by combinations, of the basic transmission media:

Radio—various types of radio can be used to take signals over mountains, deserts, and seas.

Wire—strung wire or leased lines can cover plant, urban, and rural areas.

4. INSTRUMENTATION

Bristol Metameter® Telemeters are eminently adapted to any of the conditions of measurement frequency, variables, or terrain likely to be encountered in telemetering. Transmission can be provided over telephone circuits, carrier current, radio—including microwave, VHF and UHF—and private wires, multiplexing and selective calling. Under all sorts of conditions, thousands of installations, ranging from just a few to hundreds of instruments each, have proven the dependability and reliability of Bristol Telemeters—pulse width (or duration), differential transformer, and voltage types, as well as pneumatic systems.

For more information on how Bristol Telemeters can benefit *you*, write THE BRISTOL COMPANY, 120 Bristol Road, Waterbury 20, Conn. 5.44

TYPICAL RECEIVING CENTER in multiplexed telemetering system.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

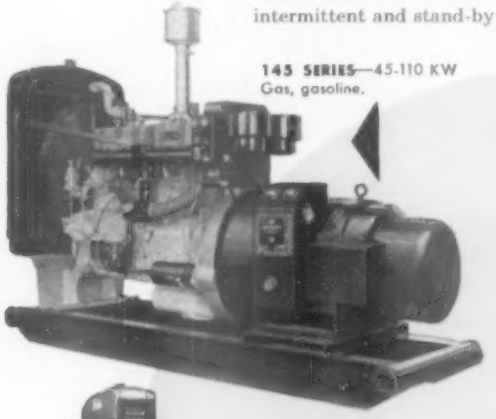
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

NOW— a complete line of
WAUKESHA
Industrial ENGINATORS®

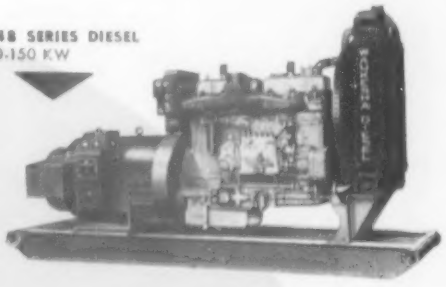
Waukesha now offers you a superb line of Enginators—backed by half a century of experience in building heavy-duty internal combustion engines and electrical equipment. Designed for reliable performance on all types of fuel, these Waukesha power units supply accurately balanced engine and generator combinations in applications requiring a smooth, steady flow of power for continuous, intermittent and stand-by duty.

50-600 KW • NATURAL GAS LPG • GASOLINE • DIESEL

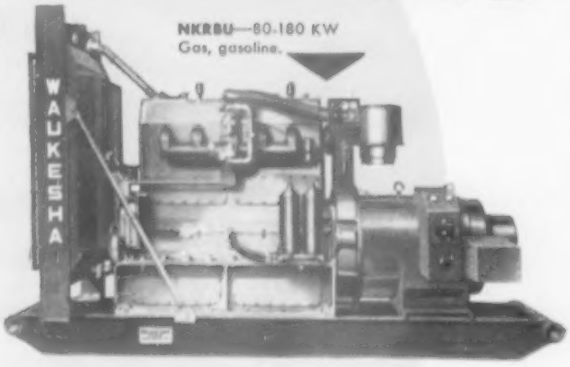
145 SERIES—45-110 KW
Gas, gasoline.



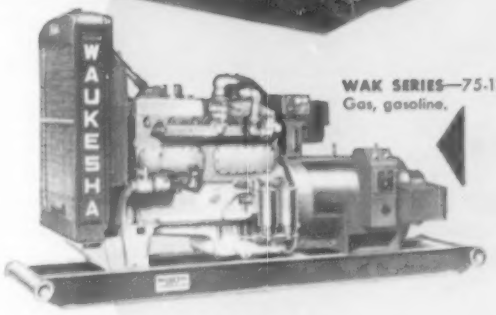
148 SERIES DIESEL
50-150 KW



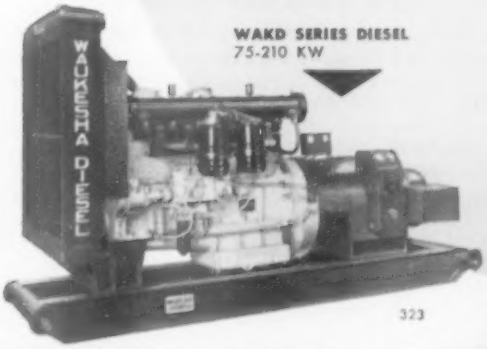
NKRBU—80-180 KW
Gas, gasoline.



WAK SERIES—75-170 KW
Gas, gasoline.

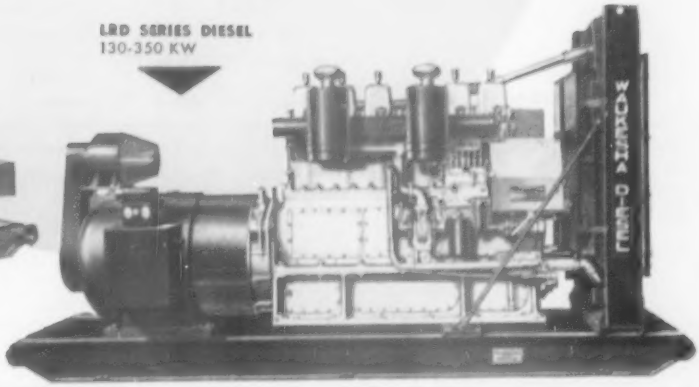


WAKD SERIES DIESEL
75-210 KW



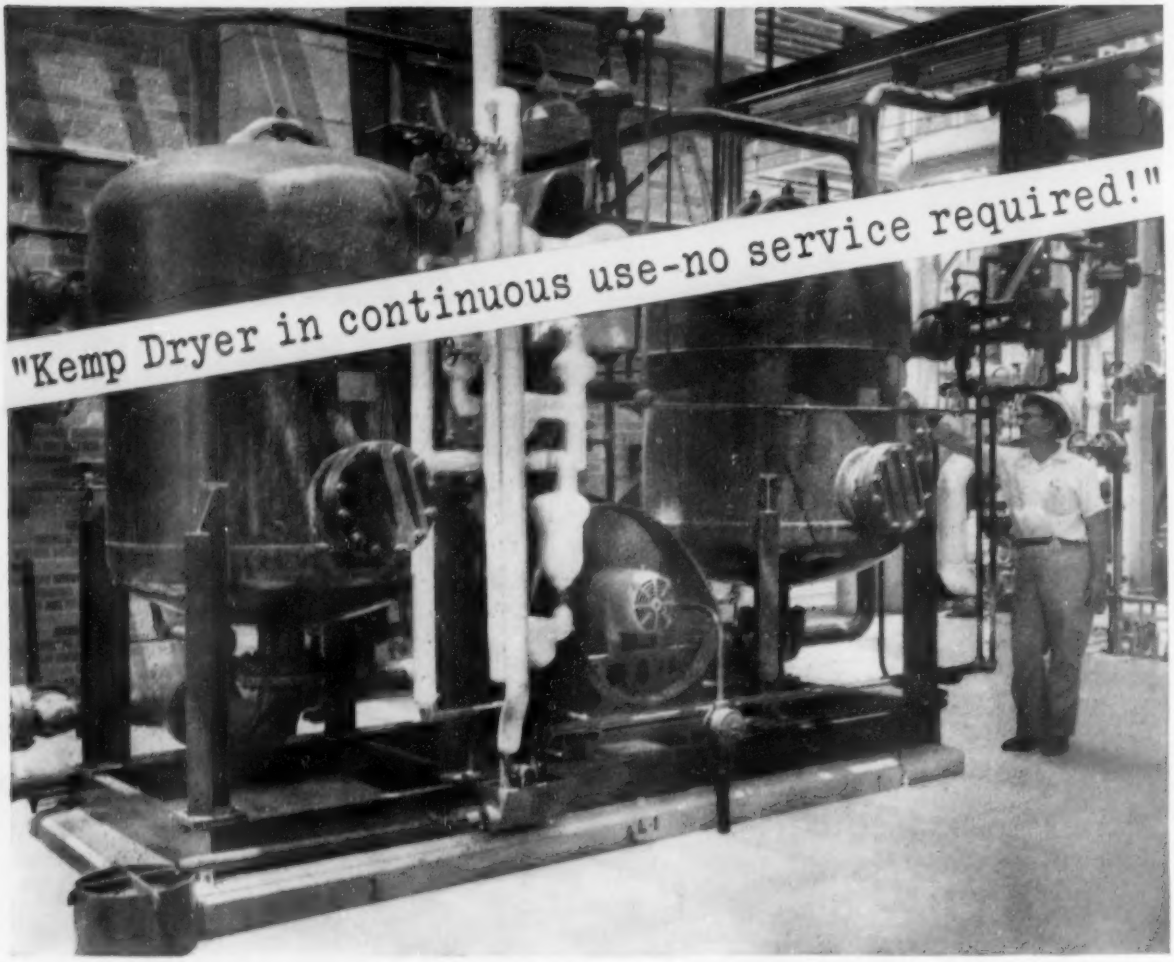
323

LRD SERIES DIESEL
130-350 KW



WRITE FOR BULLETINS FOR THESE AND OTHER MODELS.

WAUKESHA MOTOR COMPANY • WAUKESHA, WISCONSIN *RAILWAY DIVISION*



Cities Service Petroleum reports:

Kemp Dryer in continuous operation 7 days a week; has required no service or downtime!

To dry compressed air for instruments in a hydroformer unit at its refinery in Lake Charles, Louisiana, Cities Service Refining Corporation has installed a Kemp Model LC SE2 Air Dryer. Since January, 1955, it has served continuously—seven days a week—drying 1900 cubic feet of air per minute to a dew point of −10° F.

This fully automatic Kemp Dryer, reactivated every 12 hours (or 22,800 cubic feet of air), has so far required no down-time or service at all! And, according to Mr. Glendon L. Smith, Unit Engineer at Cities Service, there is practically no pressure drop from the entering pressure of 285 pounds . . . further indication of Kemp quality and efficiency.

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air, gases or liquids to sub-zero dew points at low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the removal of water from air, gases or liquids, contact Kemp now. For complete facts and technical information, write for Bulletin No. D-100.

KEMP
OF BALTIMORE

DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

THE C. M. KEMP MFG. CO.
405 East Oliver Street, Baltimore 2, Maryland

NOW, FOR DEEP OR HIGH PRESSURE WELLS:

Oil and gas well tubing 50% stronger than the highest API grades!

TIMKEN® Seamless Steel Tubing for deep well applications is available with yield strengths up to 125,000 psi, suitable ductility, good corrosion resistance

TIMKEN® seamless steel tubing, capable of withstanding internal pressure up to 15,000 psi, and strong enough for the deepest wells contemplated today, is furnished by the Timken Company in a wide range of sizes and a variety of analyses. Some of the analyses are specially selected for corrosion resistance, all are ductile when properly heat-treated.

While the strongest grade in API Specifications —5A—only calls for 80,000 psi yield strength, Timken steel tubing can be furnished with a yield strength up to 125,000 psi.

The Timken Company has already supplied such tubing for a number of extremely deep or high-pressure wells, with very satisfactory results. Actually, this only scratches the surface of our experience with high-pressure seamless tubing. For over 24 years we have been making it for many other special requirements.

FREE ENGINEERING STUDY. A recent study by the Timken Company metallurgists discusses various alloys for high-strength and corrosion-resistant tubing, and their physical properties. Write for your free copy of "Timken Oil and Gas Well Tubing" to: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

See us at the NATIONAL METALS EXPOSITION, Oct. 8-12, Public Auditorium, Cleveland, Ohio, BOOTH 1051

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Drilling Slim Holes?

Use a Slim Hole Rig—The

JOY 510

Drilling Contractors:

Drilling slim holes with a conventional rig is like driving a racing car at tractor speeds—it's wasteful. To really cut costs you have to use a rig specifically designed for slim hole work.

Here's that rig—the Joy "510." The Joy "510" drills to 5100 feet with 3½ inch drill pipe . . . 10,000 feet with 2½ inch pipe—yet it's completely portable. The "510" has *all* the features you look for in a rig:

ENTIRE DRILL UNIT MOUNTED ON ONE TRAILER for fast set-up and tear-down

AIR-OPERATED CLUTCHES for sensitive control of hoisting drums and rotary drive.

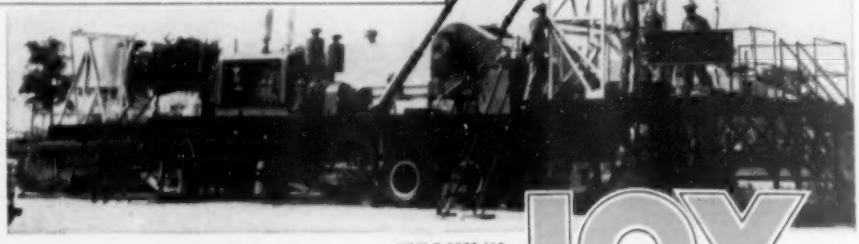
LARGER ROTARY TABLE OPENING with standard API taper passes large diameter bits and casing.

HYDROMATIC BRAKE ON HOISTING DRUM reduces excessive wear on brake linings and flanges throughout trip cycle . . . handles heavy loads . . . safer.

TORQUE CONVERTER insures complete control of load at all times . . . three times normal engine torque under stall conditions . . . permits engine to operate within its maximum power range under a wide variety of loads.

ALLOY STEEL BRAKE FLANGES have larger braking area . . . bolted to drum for easy replacement.

GET COMPLETE SPECS ON THE JOY "510". Write *Joy Manufacturing Company, Oil Field Drill Division, P.O. Box 7204, Inwood Station, Dallas, Texas.* In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



Write for

FREE Bulletin 128-31

Consult a Joy Engineer

For PORTABLE ROTARY DRILLS, AIR COMPRESSORS, GAS GATHERING COMPRESSORS, PORTABLE LIGHTING LINES

WSW O 6273-128

JOY

WORLD'S LARGEST MANUFACTURER OF CORE DRILLS AND PORTABLE OIL FIELD DRILL RIGS

PETROLEUM CHEMICALS DIVISION

NEWS

September ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Question Box

1. ARE YOU RECEIVING shipment of additives in drums in less than carload lots?
   If so, you will certainly want to read about the four-figure savings you can realize by simply revising your ordering schedule. See article at right.
2. HOW MANY different economy-grade diesel fuel problems can you lick with a single additive?
   In the article below, you may be surprised at how much one additive can accomplish for you.
3. WHO at the Du Pont Petroleum Laboratory can help you make the most efficient use of gasoline additives?
   Read about him on the next page.
4. HAVE YOU called in a doctor recently—for helping your TEL blending personnel maintain their high standards of *safe* living?
   You can find out about this unique Du Pont medical service on the next page.

To help you overcome economy diesel fuel problems

Has the growing demand for economy diesel fuels created new problems for you? Three of the most common problems encountered by refiners are:

1. Incompatibility
2. Instability
3. Sparking tendency

Du Pont Fuel Oil Additive No. 2 (FOA-2) offers you a solution to all three.

It can help you gain the needed refining flexibility by making it possible for you to blend catalytic-cracked stocks with straight-run products, and overcome the incompatibility problem.

Stabilizer and dispersant

In actual railroad service, the stabilizing and dispersant action of FOA-2 has proved highly effective for reducing the tendency of many economy-grade diesel fuels to cause filter-plugging and injector-sticking.

How much can you save by ordering Du Pont additives in tank-car lots?

Refiners can save considerable money by ordering Du Pont additives in tank-car lots. For example, 4,000 gallons delivered in a tank car, rather than in drums in less than carload lots, will save the refiner between $1,680 and $2,400, as shown in this table:

ADDITIVES	GULF COAST		MID-CONTINENT		WEST COAST	
	$ Saving	% Saving	$ Saving	% Saving	$ Saving	% Saving
Du Pont Antioxidant No. 22	$2,250	6.7%	$2,250	6.7%	$2,400	7.0%
Du Pont Fuel Oil Additive No. 2	$1,680	8.3%	$1,710	8.4%	$1,850	8.9%
Du Pont Lube Oil Additives	$1,830	12.0%	$1,860	12.0%	$2,000	12.5%

Because of the difference in freight rates, the actual dollar savings vary according to the location of the refinery receiving shipment. But no matter where your refinery is located, you will find the savings decidedly worthwhile.

How much can YOU save?

To give you the exact figures, one of our nearby representatives

OVER

Locomotive sparking, a problem which is sometimes accentuated with economy fuels, results from the formation of carbon deposits – generally during idling or while coasting downhill. The ejection of these deposits when glowing, and the resulting fire hazard, may occur during runs under heavy load.

A metallic additive is likely to aggravate this situation by increasing the size and cohesiveness of the carbon deposit particles. Field tests show, however, that an *ashless* additive does not contribute to the sparking problem. Rather, it tends to minimize it.

Du Pont FOA-2, therefore, being an *ashless*, nonmetallic additive, can help you reduce any sparking tendency in economy-grade diesel fuels.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Tank-car lots*

will be glad to call at your refinery, study your freight rates and inventory patterns. He will then determine the most convenient handling method for you and figure the exact saving you can make. You can write, wire or phone him at our nearest sales office listed below. Why not do it now?

IN ADDITION to the dollars you save on the delivered cost of the additives, you can save on handling costs by receiving additives shipments in tank-car lots.

LABORATORY GROUP HEAD

In number of miles, the distance between Havertown, Pennsylvania and Wilmington, Delaware is not far, unless, as Harold Scheule did, you go by way of Bartlesville, Oklahoma.

Scheule, who is supervisor of the Gasoline and TEL Group at the Petroleum Laboratory, was born in Havertown in 1921. Following his graduation from Bucknell University in 1943, with a B.S. in Chemical Engineering and a Phi Beta Kappa key, Harold joined the Bartlesville staff of Phillips Petroleum Company, where he remained until 1946. Since then he's been with Du Pont at the Petroleum Laboratory.

His professional affiliations include membership in the American Institute of Chemical Engineers and the American Chemical Society. He is also active in the Coordinating Research Council.

HAROLD J. SCHEULE

Du Pont medical representatives teach safety as a way of life

Hurrying back and forth across the country, and traveling overseas, too, Dr. Stewart L. Rankin covers more than 50,000 miles a year. In the course of his travels, he has firmly impressed upon more than 20,000 refinery workers his famous slogan, "Safety is a way of life!"

DR. RANKIN is shown at right with Doctors Fenton Russell (left) and L. A. Gerlach, all of the Du Pont Medical Division.

His talks on safety are part of a unique medical service which Du Pont, as a supplier of tetraethyl lead, makes available to the oil industry. In addition to the talks, Dr. Rankin and his medical associates work closely with refinery managements, physicians, supervisors and blenders to help them maintain the very finest health and hygiene programs. Practicing *preventive* medicine, the Du Pont doctors will tell you emphatically that their greatest ambition is that they *never* have to treat a case of lead poisoning.

To help them achieve this ambition, we hope you will feel free to take advantage of their services — often!

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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

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Today, all the world-wide technical, manufacturing, installation and operating experience gained by IT&T engineers since the birth of microwave is now available in one great system—

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A new age of communications was born 25 years ago when IT&T engineers conducted the world's first successful demonstration of microwave . . . across the English Channel.

In the brief span of one generation microwave has spread all over the globe. In North America, the trail was blazed by *Federal* Microwave . . . supplying tens of thousands of channel miles . . . operated by pipelines, power utilities, telephone companies, municipalities, administrations, TV stations and others . . . bringing new speed and dependability to their communications, supervisory and control operations.

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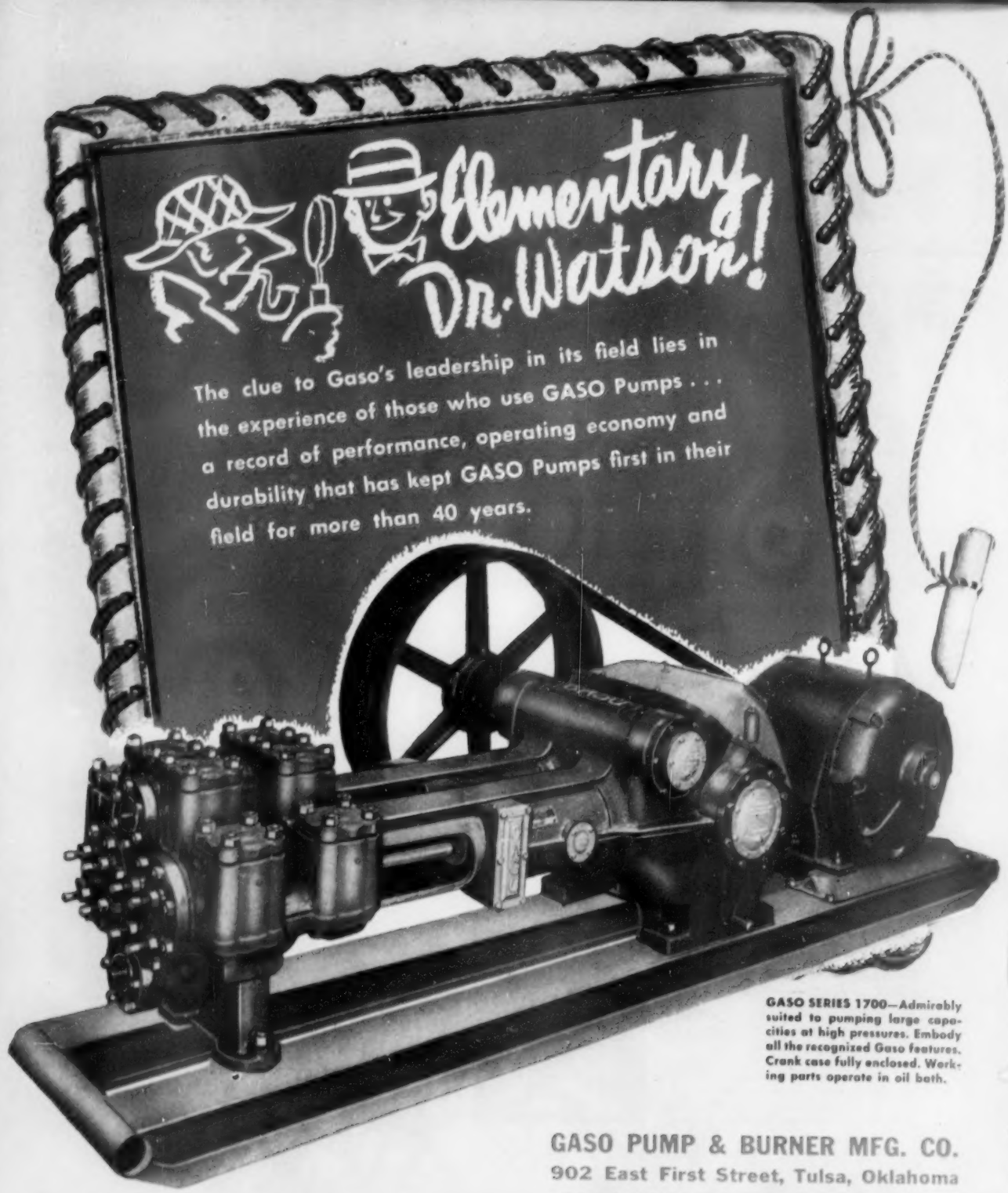
Elementary Dr. Watson!
The clue to Gaso's leadership in its field lies in the experience of those who use GASO Pumps . . . a record of performance, operating economy and durability that has kept GASO Pumps first in their field for more than 40 years.

GASO SERIES 1700—Admirably suited to pumping large capacities at high pressures. Embody all the recognized Gaso features. Crank case fully enclosed. Working parts operate in oil bath.

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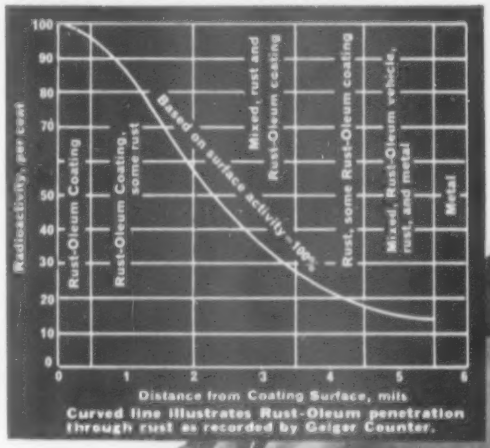
GET GASO DEPENDABILITY IN WATER FLOODING, TOO

RUST-OLEUM®

PENETRATION

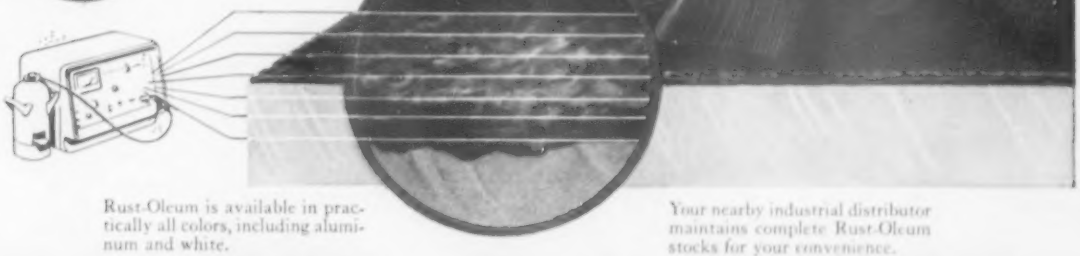
through rust to bare metal traced by Geiger Counter. To effectively stop rust—the vehicle of a protective coating, when applied over a sound, rusted surface—must penetrate through the rust down to bare metal. **Rust-Oleum does exactly that!—as proved by radioactive research!** Rust-Oleum's specially-processed fish oil vehicle was radio-activated and formulated into Rust-Oleum 769 Damp-Proof Red Primer—then applied to rusted test panels. Penetration *through rust* to bare metal by Rust-Oleum's specially-processed fish oil vehicle was then traced by Geiger Counter.

You stop rust, because Rust-Oleum's fish oil vehicle soaks deep down to bare metal and into the tiny pits where it drives out air and moisture that cause rust. You save, because this same *penetration* enables you to apply Rust-Oleum directly over rusted surfaces—usually eliminating costly surface preparations. Attach coupon to your letterhead for your thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists.



Curved line illustrates Rust-Oleum penetration through rust as recorded by Geiger Counter.

There is only one Rust-Oleum. It is distinctive as your own fingerprint. Accept no substitute. Buy—and specify only Rust-Oleum. You'll be happy that you did.



Rust-Oleum is available in practically all colors, including aluminum and white.

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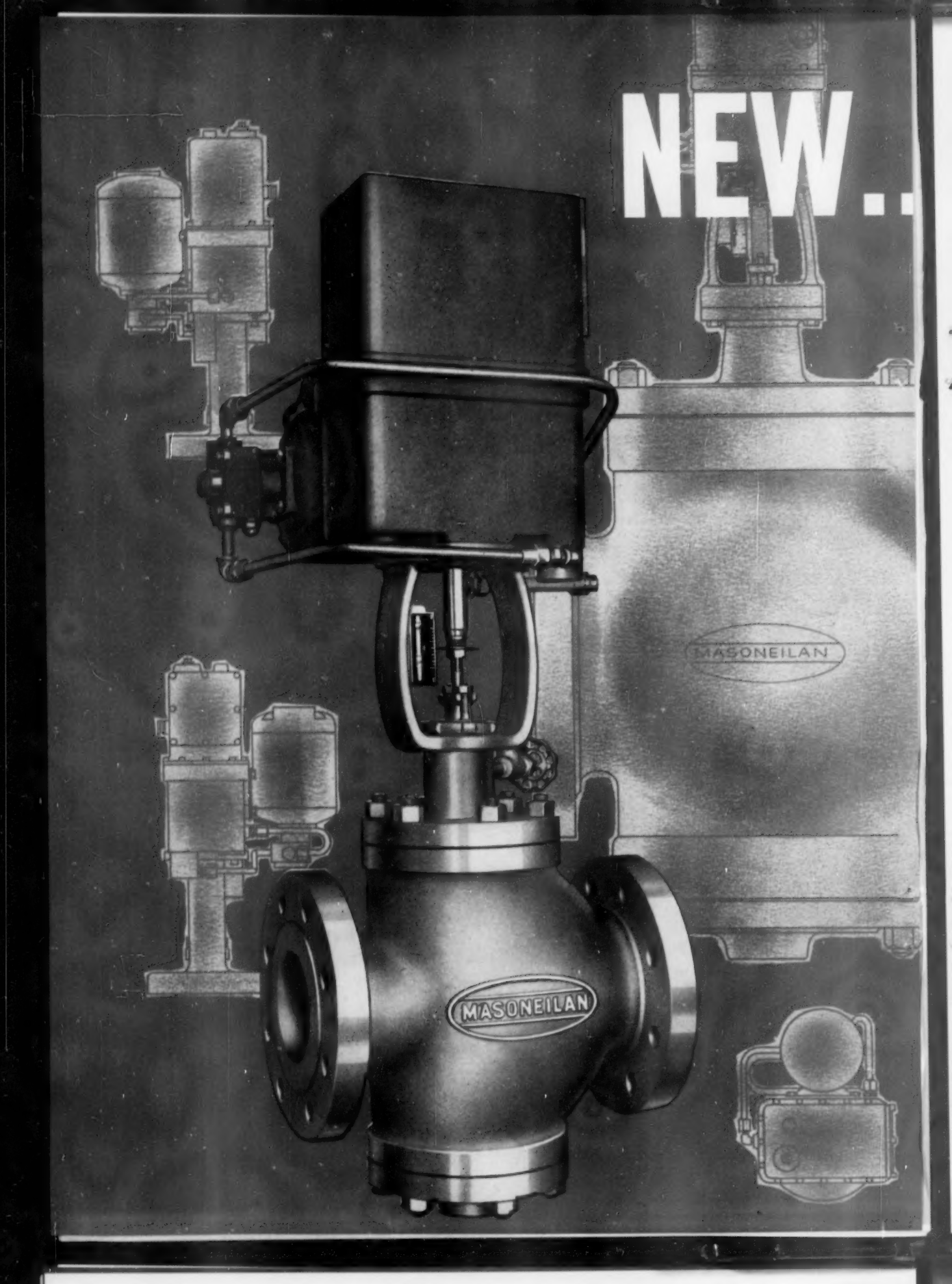
NEW..
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Electrohydraulic Valve Actuator with Premium Dynamic Performance

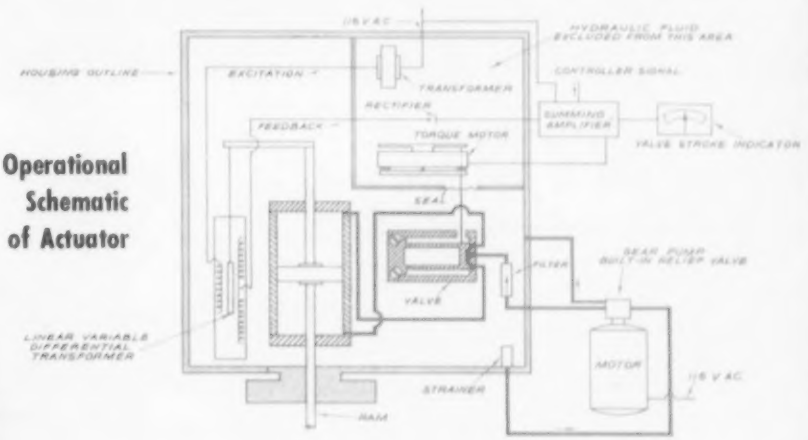
This first unit in an extensive program for the development of a complete line of electric actuators for Control Valves, incorporates the superior dynamic performance made possible by the electrohydraulic principle. It is designed primarily for the larger valves — 6″ to 16″ — requiring an extra margin of available power for reliable, positive performance and for installations where, as in remotely controlled pipeline stations, elimination of compressed air equipment makes these actuators economically feasible.

Some advantages of this actuator include —

- Maximum service life and minimum error in reproducible positioning through use of a linear differential transformer for electrical feedback
- Speed equal to, or greater than, pneumatic operation.
- Excellent linearity of plug position to signal.
- Operation with any presently available electronic control system.
- Operation under all normal ambient temperature variations.
- Availability of remote indication of valve plug position.
- Availability of explosion-proof construction. (Class 1, Group D, or other classes and groups as desired.)

Complete specifications on request

Operational Schematic of Actuator



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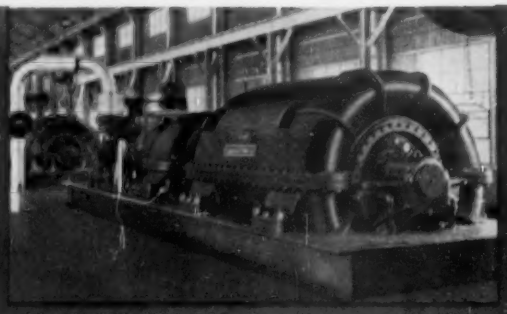
Division of Worthington Corporation
49 MAHATAN STREET, NORWOOD, MASSACHUSETTS

more than 325,000 horsepower of

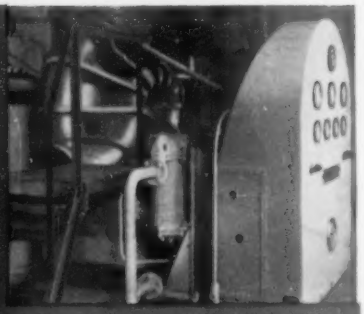
I-R CENTRIFUGAL COMPRESSORS

for NATURAL GAS SERVICE

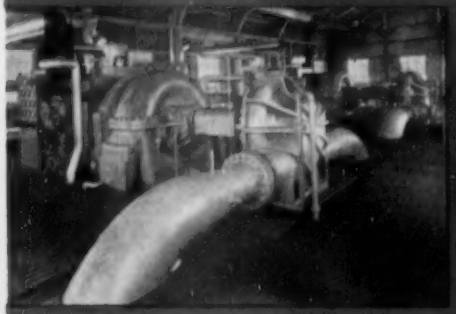
I-R centrifugal pipe-line compressor — 1250 hp, 3600 rpm, 750 psig discharge pressure.



Two 4,200 hp I-R centrifugal compressors, each handling 38,600 cfm of casing-head gas at 9.74 psig intake and 36.8 psig discharge.

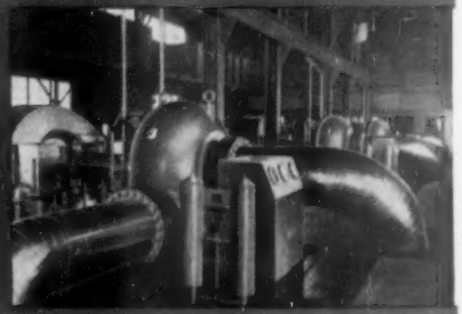


I-R centrifugal compressor boosting natural gas from 613 to 683 psig in pipe-line service.



Steam-turbine-driven I-R centrifugal gas compressors — 470 to 800 psig in 3 stages.

Ten I-R centrifugal compressors, boosting natural gas to 2,000 psig in 7 stages of compression for repressuring service.



Three of 8 I-R centrifugal pipe-line compressors with gas-turbine drive — 5000 HP, 800 psig discharge.

This experience means
LONG-RANGE SAVINGS
in modern pipe-line service

FROM THE VERY first pipe-line installation, Ingersoll-Rand has pioneered in the development of centrifugal gas compressors for higher and higher capacities and pressures. Every step of the way, dependability of performance has been a prime consideration in every detail of design and construction. This is why more I-R centrifugal compressors have been sold for natural gas service than any other make — a total exceeding 325,000 hp for this service alone. Backed by such long and successful experience, the modern I-R centrifugal gas compressor is your best assurance of trouble-free performance and long-range economy.

Ask your I-R representative for the complete, cost-saving story on centrifugal compressors for every service.

I-R *"FIRSTS"* in Centrifugal Gas Compressor History

FIRST **Centrifugal Pipe-Line Compressor**

FIRST **Gas Turbine Driven Centrifugal Pipe-Line Compressors**

FIRST **2,000 psi Centrifugal Gas Compressor**

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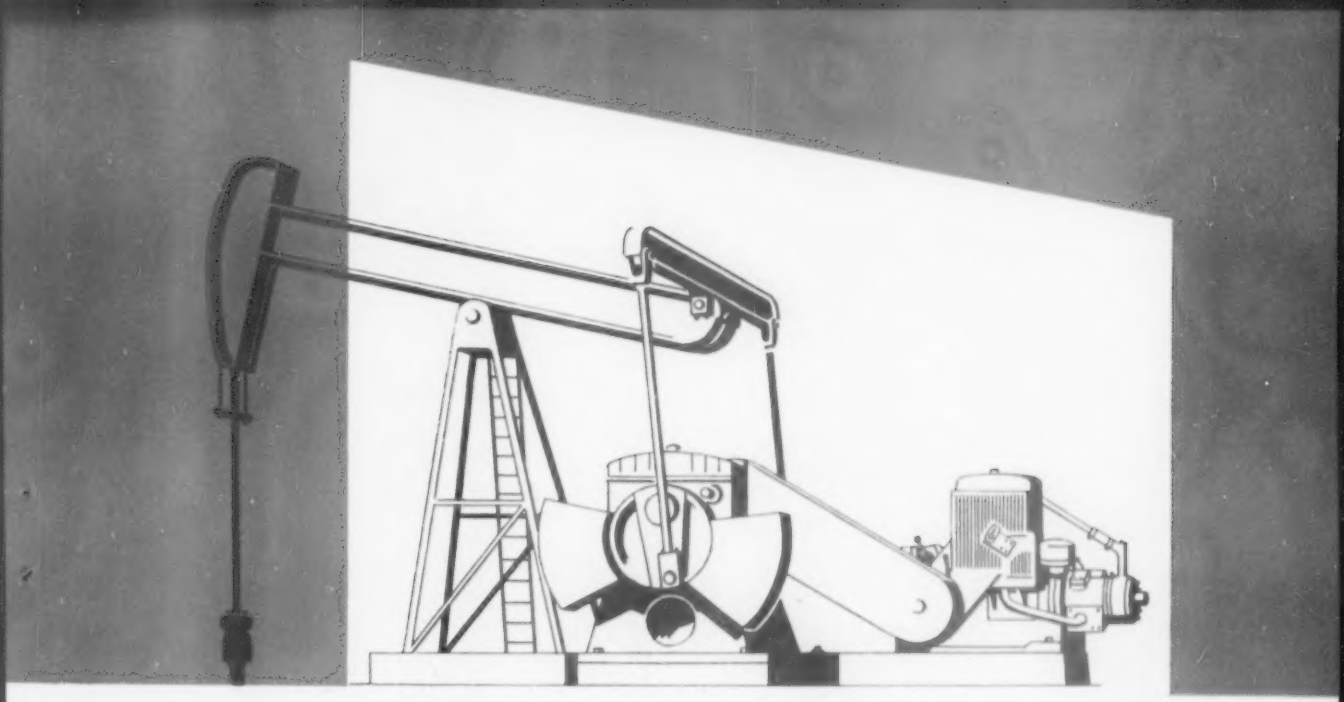

HOW TO LOWER PRODUCTION COSTS:

Power your pumper

WITH *Ajax* and *Gas*

The fog of questions about rising production costs and narrowing profit margins can be swept away by a single sunlit fact: you can usually save half the cost of your engine each year with AJAX and gas! After two years, you have only negligible maintenance and fuel to pay for—from then on out, years of continued profit. More facts? Write us—see your Supply Man!

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Builders of GAS AND OIL ENGINES, PRESSURE PUMPS, STEAM DRILLING ENGINES, INDUSTRIAL STEAM ENGINES

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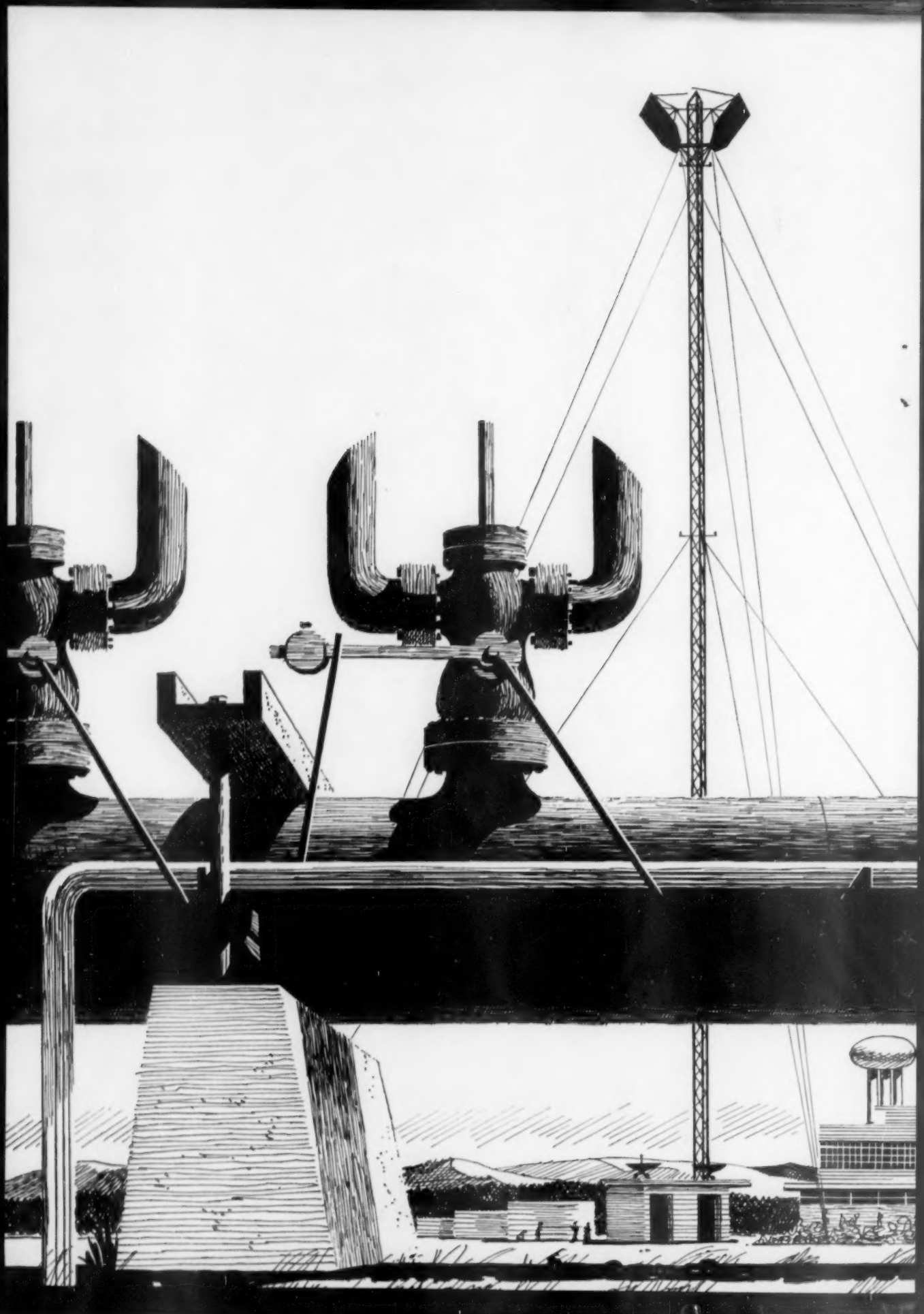

COLLINS

MICROWAVE

highly reliable communication and control for pipeline operations

Basically, Microwave gives you your own private communication system. Your system can link pump or compressor stations, terminals, office buildings, refineries, and other operating locations. In addition to private voice circuits, you will have channels for telemetering, remote VHF station operation, automatic load control, centralized office accounting, Teletype, and facsimile transmission.

Collins Microwave, incorporating Collins mechanically-filtered single sideband multiplex, is designed for expansion to 120 channel capacity, continuity of operation, and ease of maintenance. Collins engineering services are readily available for evaluating, planning, and installing your Microwave communication system.

Collins CREATIVE LEADER IN COMMUNICATION

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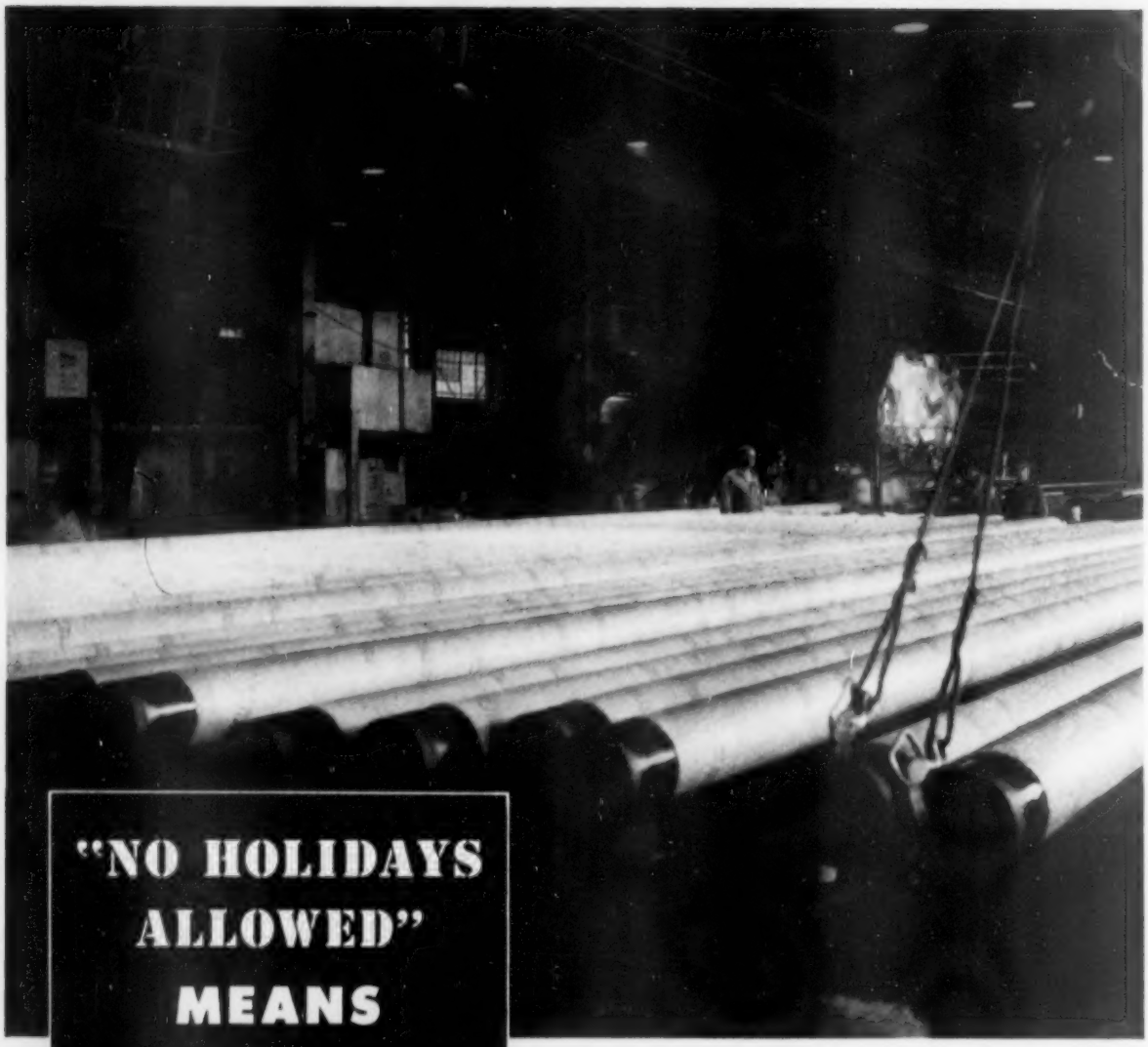


"NO HOLIDAYS ALLOWED" MEANS BETTER PIPE PROTECTION!

When is a holiday not a vacation? When it's an imperfection in the coating and wrapping. Such a weakness cannot possibly escape detection at Hill, Hubbell. For in a final step, all Hill, Hubbell processed pipe goes on inspection skids as shown above. Then each square inch is carefully examined by an electronic Holiday Detector before the pipe leaves the plant. One of many quality controls developed by Hill, Hubbell, the use of Electronic Holiday Detectors is simply—

Another "first" pioneered by the first name in pipe protection

FACTORY APPLICATORS OF COATINGS AND WRAPPINGS

HILL·HUBBELL & COMPANY

DIVISION OF GENERAL PAINT CORP. • 3091 MAYFIELD ROAD, CLEVELAND 18, OHIO

RIGHT DOWN OUR ALLEY

This is "pipe alley" in a large Midwestern refinery. It is made up of connecting lines between refinery units and storage tanks. Such "pipe alleys" are highly practical to a refinery since all the pipe is confined to one area, and the lines are kept above-ground where they are easily accessible for inspection and maintenance.

Over 70,000 feet of the pipe in this alley is NATIONAL Seamless, "Walls Without Welds," 12¾-inch O.D. with .375-inch wall.

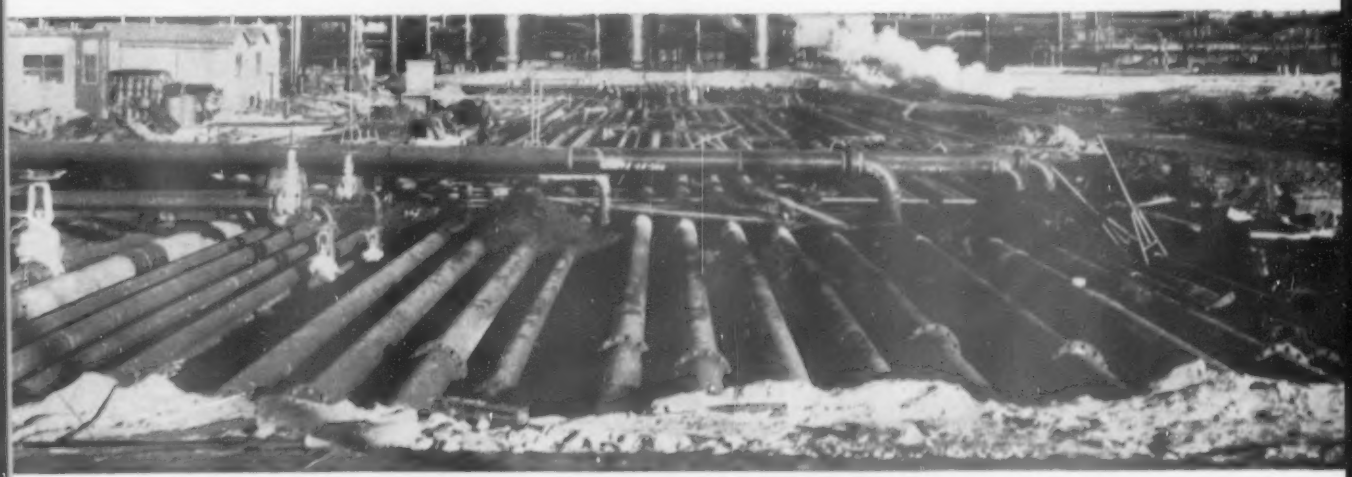
* * *

Refinery pipe and tubing problems are "right down our alley." We manufacture NATIONAL Seamless Pipe and Tubes in over 2 dozen different steel analyses, each designed to counteract specific refinery problems such as corrosion, oxidation, pressure and temperatures. Other chemical compositions are also available in tubular products, and at the present time, a wide variety of high temperature problems is under study.

If you have a refinery tubing problem, we'd like to give you a hand with it. We have a technically trained Mill Service Force available to you for technical and operating assistance in meeting your tubular requirements. This Force is also available for consultation in the field. We'll see that you get the right tubing for the job, at the lowest cost. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

TWO DOZEN DIFFERENT NATIONAL TUBE ANALYSES:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni

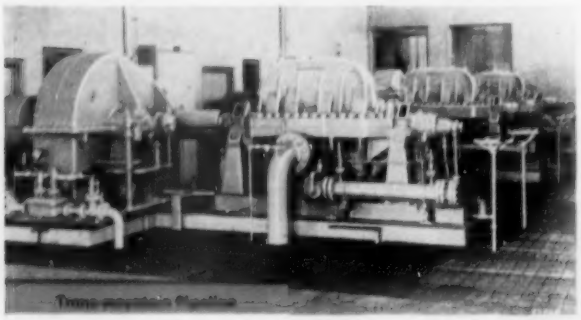


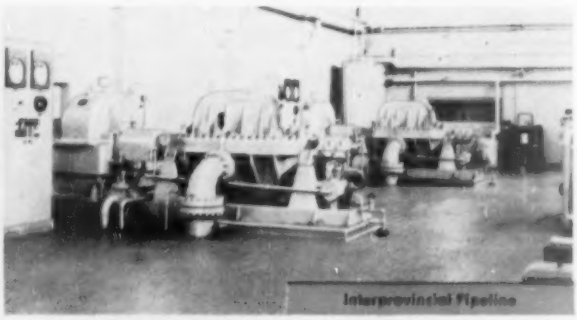
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

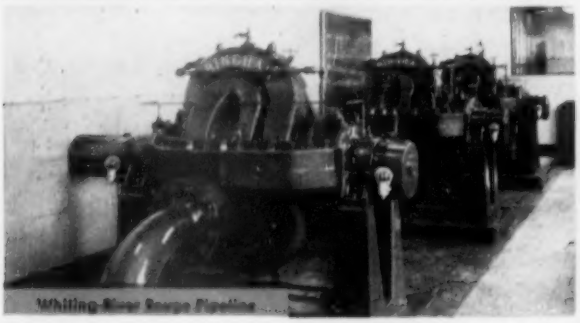
USS **NATIONAL SEAMLESS PIPE AND TUBES** WALLS WITHOUT WELDS

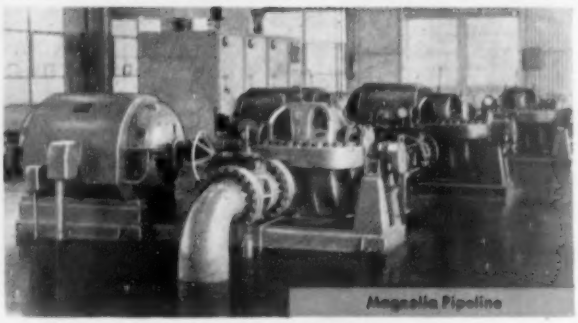
UNITED STATES STEEL

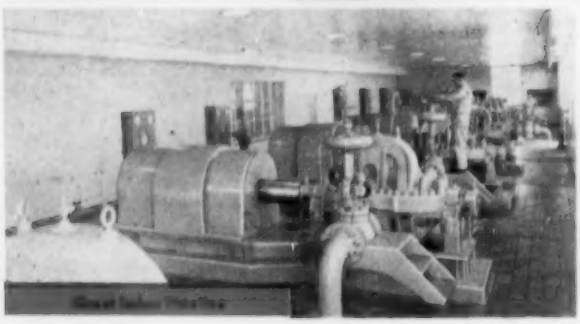
2 BIG REASONS WHY MAJOR PIPELINES

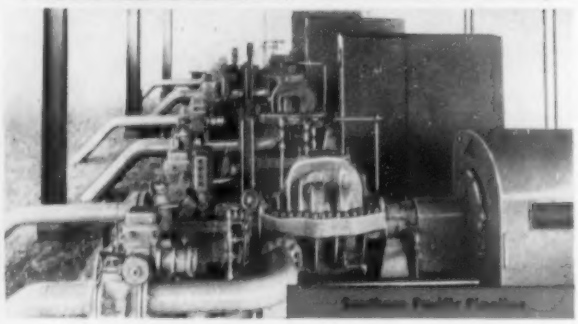












PARTIAL LIST OF MAJOR PIPELINES WITH BINGHAM "DOUBLE VOLUTE" PUMPS IN OPERATION OR ON ORDER

Brazilian Gov't Pipeline
Buckeye Pipeline
Cherokee Pipeline
Great Lakes Pipeline
Interprovincial Pipeline
Interstate's Southern Main Pipeline
Kaneb Pipe Line
Lakehead Pipeline
Mackinac Pipe Line
Magnolia Pipeline
Minnesota Pipeline
Oklahoma-Mississippi River Pipeline
Pembina Pipeline
Pemex Pipeline
Plantation Pipeline
Service Pipeline
Southern Pacific Pipeline
Spanish Air Base Pipeline
Standard Oil of Indiana Pipelines:
1. Dubuque-Moorhead Pipeline
2. Mandan-Moorhead Pipeline
3. Whiting-River Rogue Pipeline
Sun Pipeline
Tidewater Associated Pipeline
Trans-Mountain Pipeline
Trans-Northern Pipeline
Tuscarora Pipe Line
Western Pipeline

SELECT *Bingham*

. . . "DOUBLE VOLUTE" PUMPS

1 LOW MAINTENANCE. Bingham Pipeline Pumps are of "Double Volute" design, insuring perfect hydraulic radial balance of rotating element. "Hydraulic Radial Balance" eliminates unequal pressures on the rotating element—"**Side Push**"—which is the primary cause of wear and maintenance in conventional pumps. Also this feature, which eliminates shaft deflection, permits **mechanical seals** to establish and maintain uniform track between the contacting faces. This prevents leakage and seal face wear, resulting in *long seal life*.

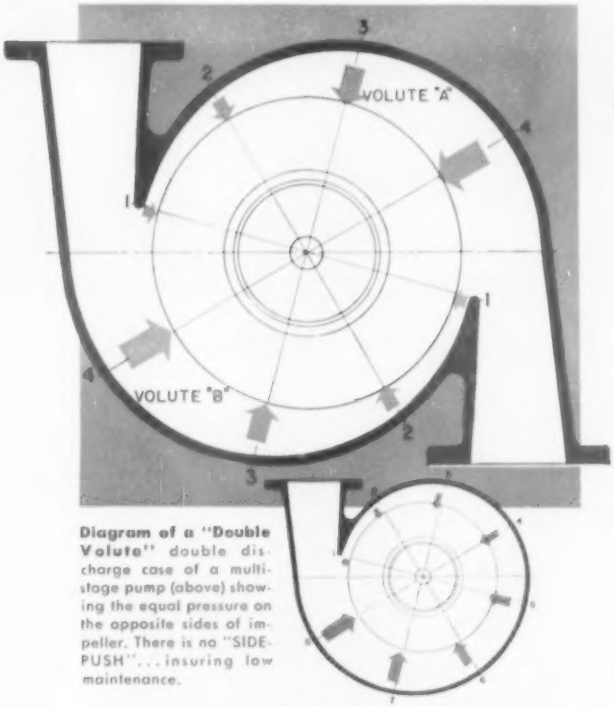
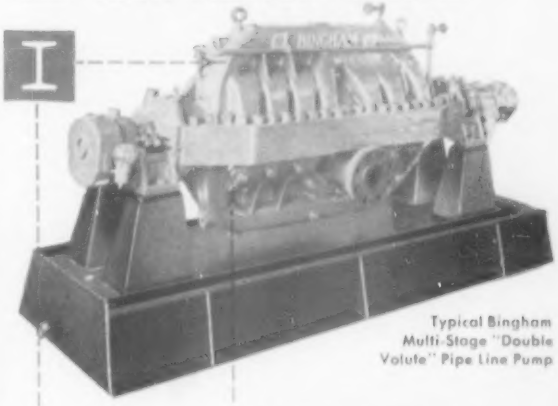


Diagram of a "Double Volute" double discharge case of a multi-stage pump (above) showing the equal pressure on the opposite sides of impeller. There is no "SIDE-PUSH"... insuring low maintenance.

Diagram of "Single Volute" pump case (immediately above) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

2 ASSURED CASE STRENGTH FOR HIGH-PRESSURE SERVICE



Typical Bingham Multi-Stage "Double Volute" Pipe Line Pump

A transverse cross-section of Bingham "Double Volute" Multi-Stage Pumps, showing identical cross-overs cast integrally with the upper and lower halves of the pump casing.

Integral cross-overs in Bingham "Double Volute" multi-stage pumps produce casings of maximum strength for high pressure service because each cross-over is cast integrally with its half of the pump casing, and thereby becomes a structural member of Bingham's "I-Beam Truss Construction".

This feature, found only in Bingham pumps, increases the strength of the pump casing to such an extent that it can safely withstand operating pressures up to 2000 psi with standard construction (higher pressures with special construction).

Bingham "Double Volute" Multi-Stage Pumps will best serve your pipeline operations, as they are now serving major pipelines. Write to your nearest Bingham office for "Double Volute" Bulletin or additional information.

Bingham
SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**
Factories: **Portland, Ore. • Vancouver, B. C., Canada**

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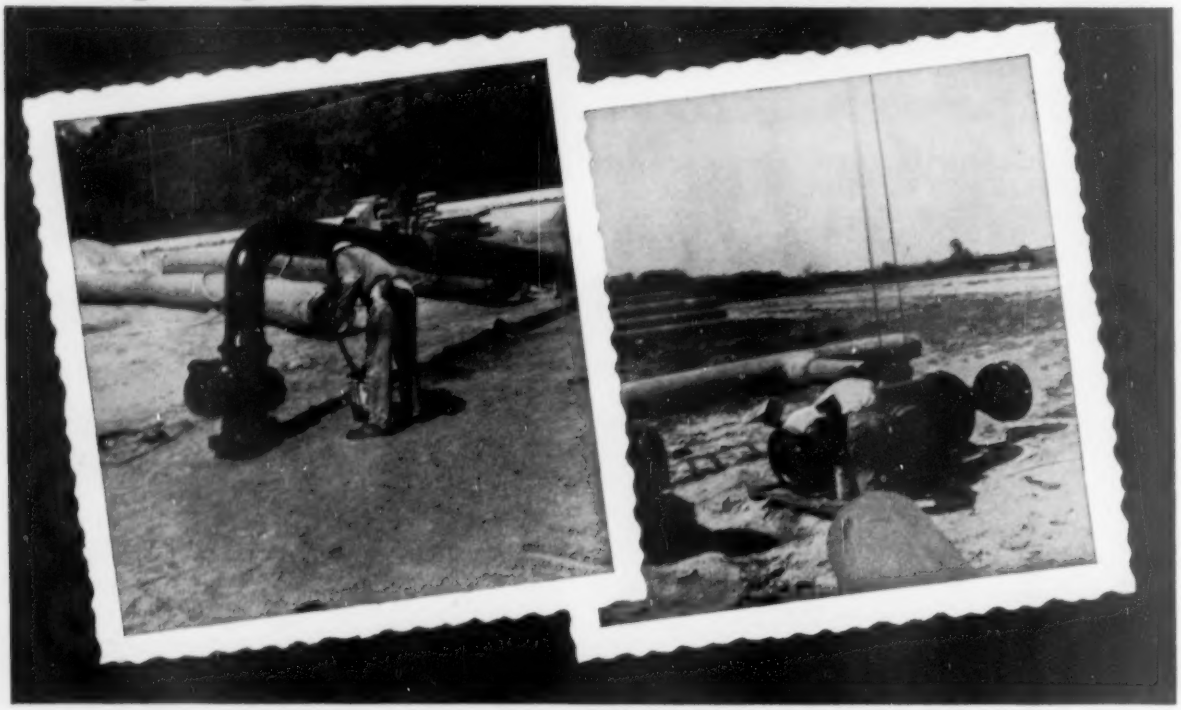
TARSET® Protects Valves and Piping on T.G.T. "Muskrat" Line



New Pitt Chem Coal Tar-Epoxy Coating Selected for Maximum Protection in Rugged Marshland Area

In the swampy marshland terrain where Tennessee Gas Transmission Company is laying most of its new 24-inch "Muskrat" gas line, superior protection against corrosion becomes just as vital for above-ground equipment as for the underground line itself.

Relying on Pitt Chem Modified Enamel, in part, for underground main line protection, T.G.T. engineers specified another Pitt Chem product, new cold-applied *Tarset*, for the protection of main line gate valves, headers and other above-ground equipment on the gathering system.

Since the first application of Tarset in sour crude storage tanks, the use of this revolutionary coal tar-epoxy coating has spread rapidly to the gas industry and many others. *For no other cold-applied material available today offers such durable protection at such a moderate cost.*

What's *your* corrosion problem? Chances are this rugged, heavy-duty coating can help you solve it. *Write or call today for newest Tarset performance data and other helpful information.*

PITT CHEM® TAR BASE COATINGS

- Standard Grade
- Modified Grade
- Plasticized Grade
- Hotline
- Cold Applied Tar Base Coatings

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

Layne Research

7 ways it serves and saves

1. FIELD CONSULTATION: Expert technicians, trained and experienced in all phases of ground water development, are available to Layne clients through Layne associate companies.

2. TRAINING LAYNE PERSONNEL: Layne field operators are trained in new techniques and in the use of materials proved in practical applications as well as in the laboratory.

3. CORROSION PREVENTION: Rust and other corrosion prevention, through the use of properly selected materials for well casings, screens and pumps, including cathodic protection by sacrificial metals and the use of tested resistant paint coatings, are major research developments.

4. REHABILITATION OF EXISTING WELLS: Major expense is often avoided by rehabilitating existing wells and developing new wells by methods initiated in the Research Division.

5. SELECTION OF WELL SCREENS TO WELLS: Well screens, gravels and formation sands are correlated to secure maximum trouble-free water productions with a minimum of screen losses, as the result of Layne Research.

6. IMPROVED WELL CONSTRUCTION TECHNIQUES: Work of the Research Division has resulted in many new materials, including Laynite well cements for sealing well surface casings, Laynite additives for treatment of wells, and Laynite rotary drilling muds.

7. ANALYTICAL STUDIES: Basic research determining corrosion causes, deposition of minerals, micro-bacterial growths, effects of dissolved gases and remedial treatments, is an ever-continuing subject for the Research Division.

Layne — Industry — Municipality — Agriculture

Water Wells • Vertical Turbine Pumps
Water Treatment

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There's a PLS plant strategically located to serve YOU!

weather" in a PLS plant!

Under the roof—out of the open air—is the best possible climate for *controlled* pipe protection. It isn't simply a case of being able to continue production in spite of rain . . . but rather the cleaning, priming, coating and wrapping of pipe under *controlled conditions:* where machinery can be more elaborate and more carefully synchronized . . . where dust and open field debris can't cause a lack of quality and uniformity . . . where visual and mechanical inspection is far more accurate.

Perfect "coating weather" and *controlled protection* are now available to you in *eight* completely equipped Pipe Line Service plants. They're strategically located across the country, from Monmouth Junction, N. J., to the brand-new plant at Provo, Utah. Big acreage is provided for your convenience—and so that the *delivery date you specify is the date we meet.*

Call in your nearest Pipe Line Service representative. He can show you how to get the highest possible return on your pipe-protection investment.

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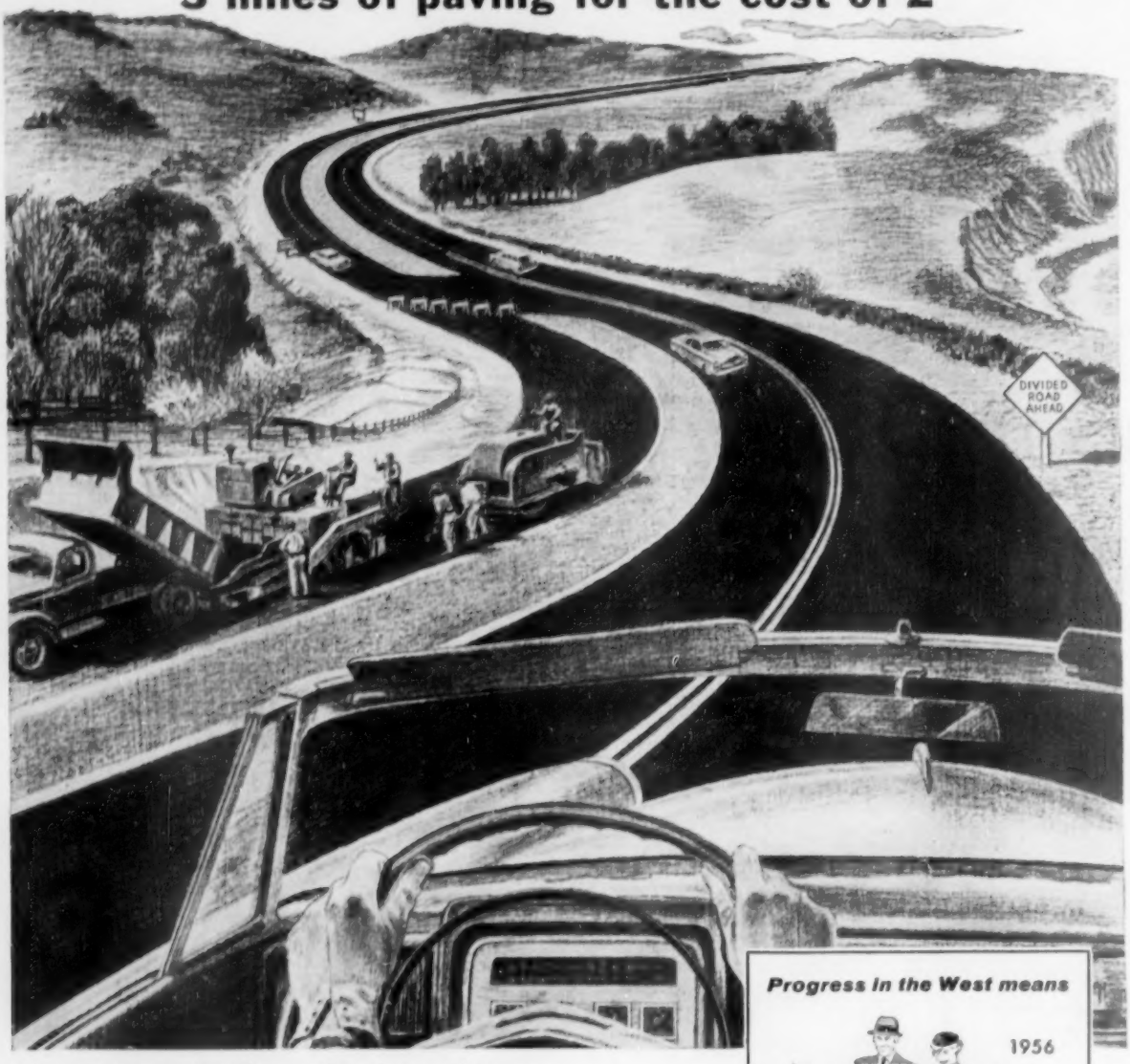
Pipe Line Service Corporation

FRANKLIN PARK, ILLINOIS

Quality pioneers in coating and wrapping pipe for a quarter century

Standard asphalt research helps bring taxpayers 3 miles of paving for the cost of 2



You are more comfortable, get there faster, when you drive on safe, modern roads of sturdy and resilient asphalt.

CROWDED HIGHWAYS waste motorists' time—and lives. To build more miles of better roads at lowest cost, highway engineers turned to asphalt paving for 85% of the nation's roads. They find asphalt costs 30 to 50% less than other pavements. It lasts longer, reduces headlight and sunlight glare, provides noiseless, comfortable driving. To help meet the nation's highway needs, Standard* has expanded its asphalt production across the country, now operates nine asphalt refineries.

Our scientists work with highway engineers on improved construction techniques which save millions of your tax dollars each year. This means more and better roads, to serve a nation on the move.

Progress in the West means

20,000 miles of additional highway construction by 1965

**through Standard's wholly-owned subsidiary, American Bitumuls & Asphalt Company*

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Fast, powerful – that's the power-packed story of American Bosch Magnetos – today's finest ignition units for oil industry engines. Many advanced features give these famous Magnetos greater power for split-second starting, PLUS the built-in stamina that assures years of constant, trouble-free operation in Drilling, Producing, Pipe Line and Refinery service. That's why they're so widely used as original equipment by so many leading engine builders.

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Automotive and Aviation Magnetos

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Components for Aircraft Engines

AMERICAN AB BOSCH

Small Electric Motors

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Diesel fuel injection equipment

Every refiner is facing a constantly increasing demand for higher octane gasolines. Whether or not he makes money may well depend on his being able to provide these efficiently and economically. For today's and tomorrow's requirements one high octane stream just isn't adequate to provide the essential quality in pool gasoline. The most practical way this can be done is through an improvement of the poorer quality blending components that presently drag down pool gasoline octanes.

This is why much of UOP's research has been constantly directed toward the improvement of the poorer components that reduce pool gasoline quality. This has resulted in the recent development of PENEX, UOP's newest refinery process. Through isomerization, PENEX provides a means of up-grading pentane and hexane fractions, the previously neglected components that definitely lower pool gasoline octanes.

This is a mighty poor spot for a refinery...

The future success of your business will depend on getting the most out of every drop of oil that passes through your refinery. To do this it is essential that your planning be geared to the necessity of achieving the highest possible octanes in your pool gasoline. Find out now how the PENEX process will help you accomplish this, and make it part of your planning for a continuing successful operation.

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Forty Years of Leadership in Petroleum Refining Technology

PENEX
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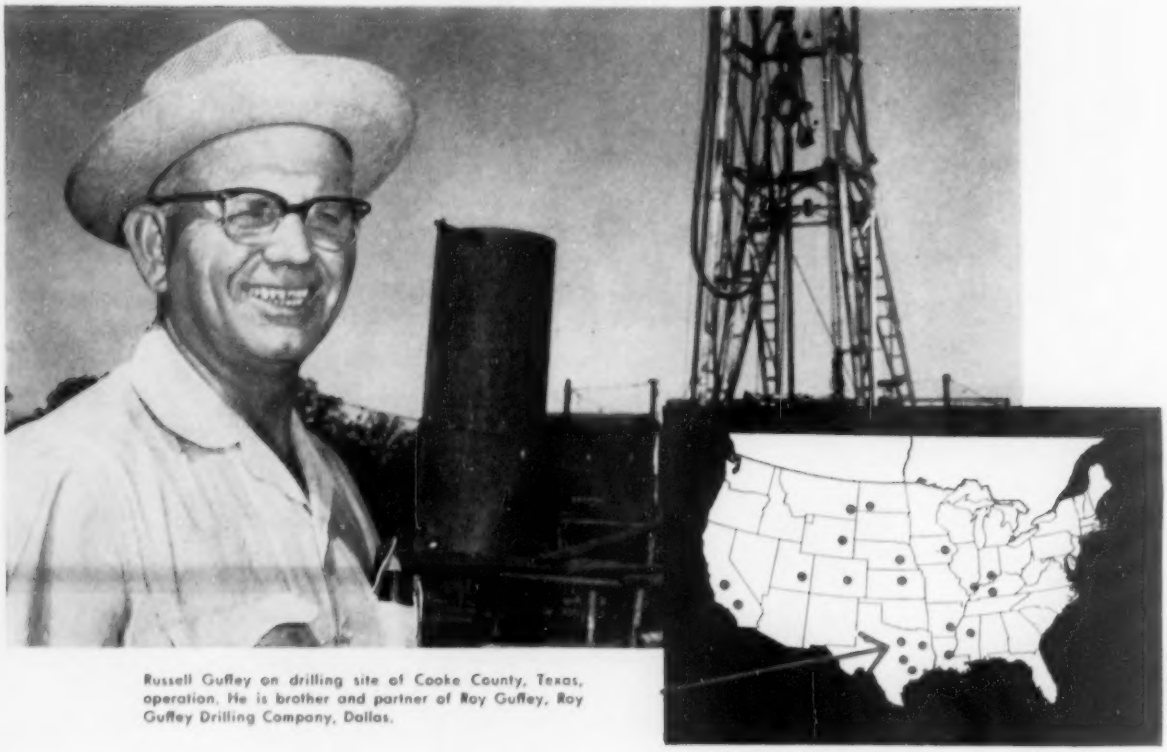
A new isomerization process for up-grading pentane and hexane fractions

Oil Financing from the **FIRST** *in* **DALLAS**
goes where you go...



Russell Gufley on drilling site of Cooke County, Texas, operation. He is brother and partner of Roy Gufley, Roy Gufley Drilling Company, Dallas.

Specialized experience, organization, and resources
to help you with practically any kind of
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PIPELINER

LORAIN 26

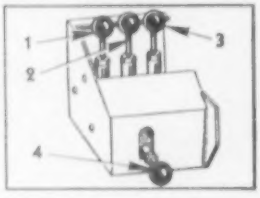
The Lorain-26 Pipeliner is the result of years of field study, experience and testing. On job after job, the following features have proved to be the things most needed for rough, tough pipelining work. Lorain "E-Z" Controls reduce operator effort by 70%. Hydraulic Power Crawler Controls (see right) add further to ease of operation, make it easy and fast to move crawler as digging progresses. Independent travel is also available. A longer, stronger 19-ft. gooseneck boom gives maximum digging ranges, digs harder materials. Larger 18" clutches result in faster, smoother response, longer clutch life. Idler rollers on anti-friction bearings are nylon sealed for protection against mud or sand. Wider, 2-speed crawlers are equipped with 29" treads. A new shell lagging takes larger drag-in cable for longer cable life.

There are many more facts you should check in the heavy-duty 3/4-yd. Lorain-26 Pipeliner. Your Thew-Lorain Distributor can tell you what every feature means in terms of performance—and profits!

THE THEW SHOVEL CO., LORAIN, OHIO

NEW... Hydraulic Power Crawler Controls

Here's more operating ease and quicker response in the new Lorain "26". From the operator's cab — with turntable in any swing position — the operator simply flicks these levers — and these actions take place immediately . . .



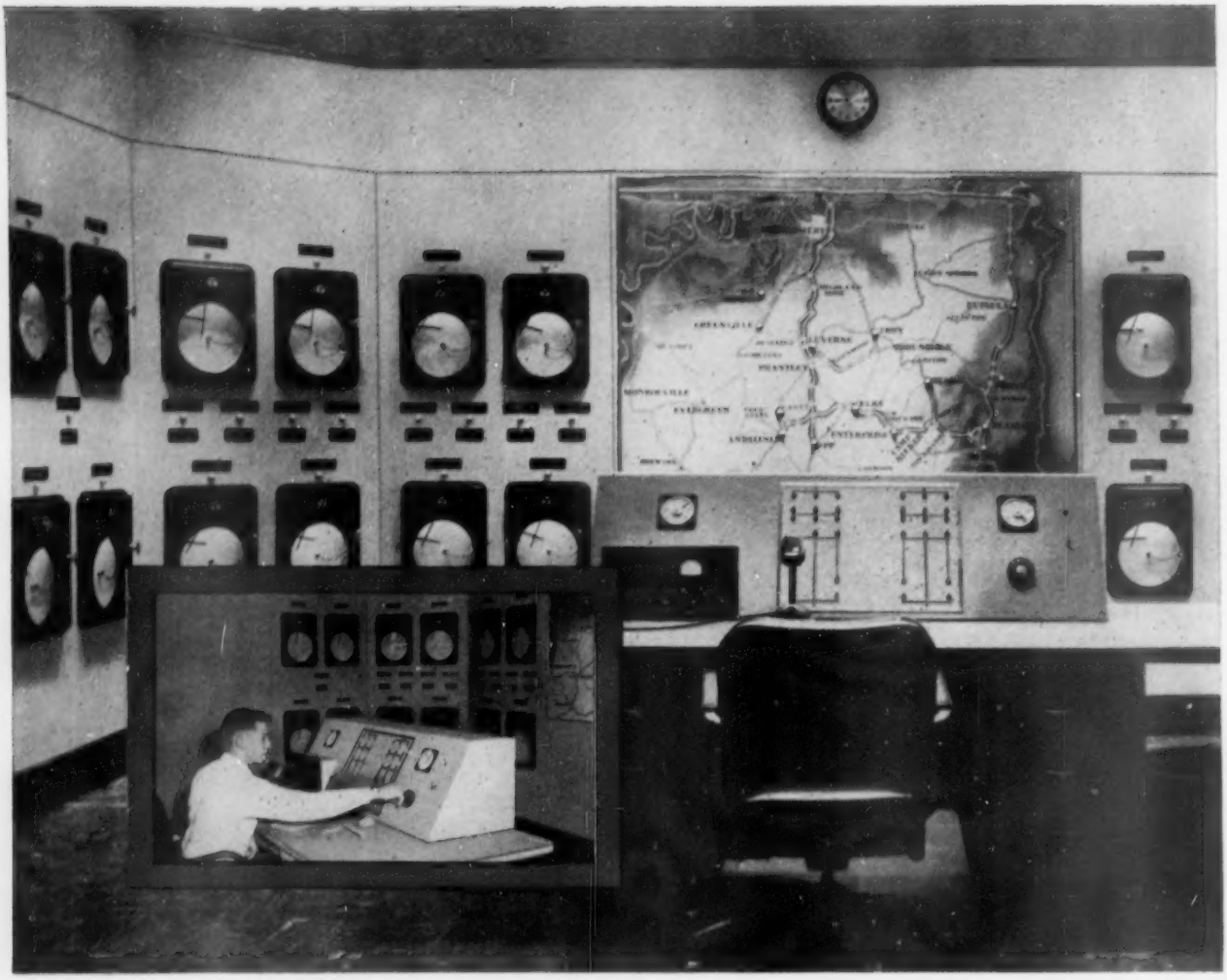
1. HOUSE LOCK is engaged promptly by power and released instantly by this handy, easy-acting lever, to prevent side motion of turntable.

2. SWING AND TRAVEL JAW CLUTCHES are selected and engaged by simply flipping this lever . . . push forward to travel . . . pull back lever to swing.

3. LOCKING PAWLS, now fully enclosed and mud protected, are instantly engaged and released by fast-acting power.

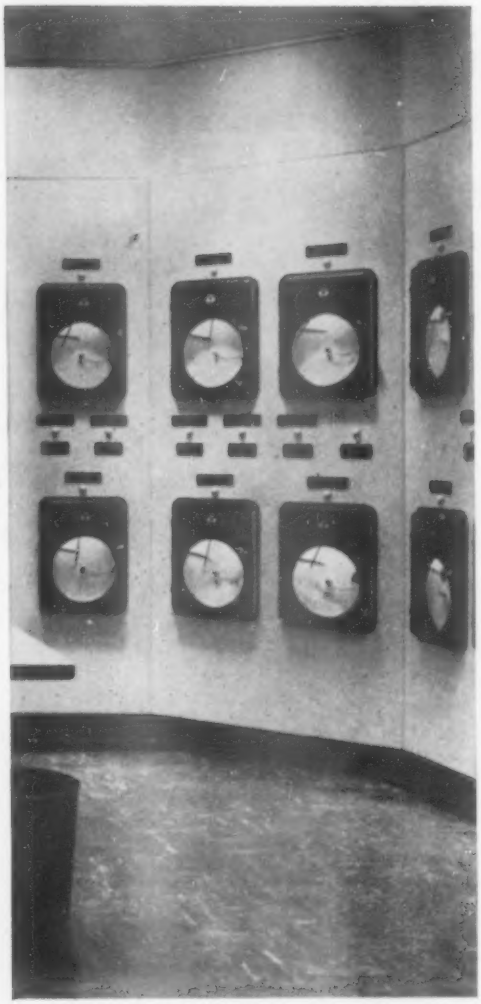
4. CRAWLER STEERING is power controlled by a single short lever — no operator effort, no fatigue. Either right or left steering is effected while traveling forward or backward, with turntable in any position of swing.

THEW-LORAIN 26 PIPELINER

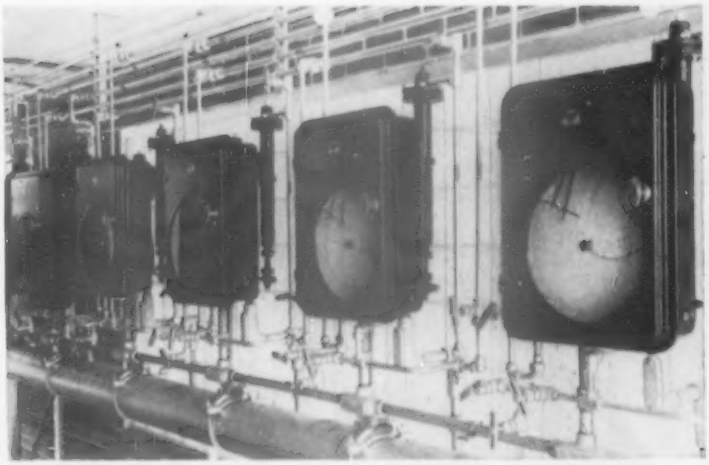


Remote Control of Flow and Pressure for 24 cities and towns in Alabama

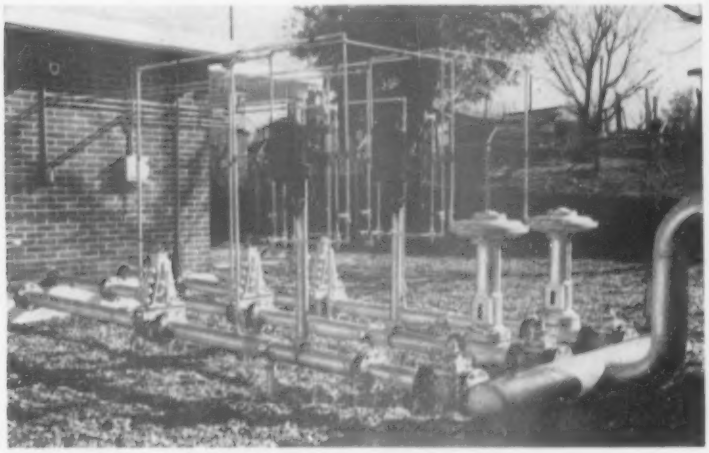
ANOTHER ALL AMERICAN® INSTALLATION — From a centrally located desk in Andalusia, Alabama, one dispatcher, by remote control, regulates the flow of gas for the 24 cities in the Southeast Alabama Gas District—largest municipal natural gas system in the world. The 120 years engineering and precision manufacturing experience of American Meter Company assisted by supplying equipment for this new type modern gas measurement and control installation to bring the advantages of natural GAS to one of the fast-growing areas of the United States.



DISPATCHER STATION – By dialing a single circuit, dispatcher obtains total flow in cubic feet and pressure from each of the 14 city gate stations, plus total flow in cubic feet, pressures and differentials of orifice meters and controllers at each intake station to permit complete remote dispatching.



INTAKE STATIONS— All measurement at intake stations, 90 miles and 120 miles from dispatcher's desk, is combined in a totalizing relay which in turn is put on a memory relay to supply total flow since last dialing.



CITY GATE STATIONS – Each station has American automatic measurement, pressure and regulation equipment, totalizing relays and memory relays, enabling dispatcher to obtain flow for any period and obtain pressures. Complete remote control of dual flow differentials, dual first and second stage regulators.

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LOOKING FOR EXTRA OCTANES?

...they've been found with

AEROCAT® CATALYSTS

A survey of 42 cat crackers showed that those using Aerocat were averaging 2½ octanes higher than comparable units operating with natural catalyst! But extra octanes are only one of the benefits assured by Aerocat. High throughput, low stack loss and excellent stability contribute to the high overall efficiency.

Equally important... behind AEROCAT'S *efficiency stands*

OPEN-EYED RESEARCH... that keeps making innovations in catalyst design... keeps looking for new ways to solve catalyst problems.

HARD-HEADED QUALITY CONTROL... that insists on "specification *plus*" in every carload that leaves the plant.

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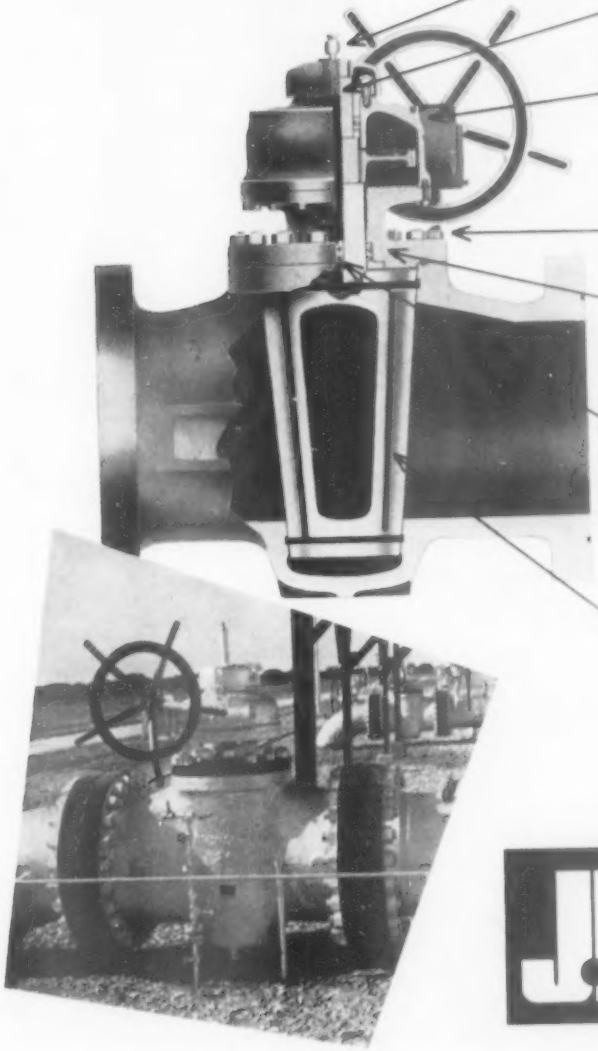
LET'S EXAMINE WALWORTH LUBRICATED PLUG VALVES



Button-head lubricant fitting and lubricant screw. Screw is not removed when using a Walworth High Pressure Lubricant Gun.

Lubricant-Fitting screw has "Telltale" safety groove.

For buried pipelines this yoke design permits simple attachment of hand-wheel and lubrication extensions without modifying the gearcase.

Standard bolt threads, rather than special threads, permit easy replacement from local stocks.

Two overlapping Teflon packing rings form an effective seal against leakage without "grabbing" the plug shank. Packing serves only as a seal and is not used to hold the plug in its seat.

In the stainless steel check valve unit, a transverse pin holds two balls in their seats. There is no chance for line pressure to get into the lubricant system when the valve is properly adjusted and lubricated.

Lubricant grooves completely frame the port openings and encircle the plug at the top and bottom, assuring a tight seal against leaks. Bottom circumferential groove is separate from, but connected with, the lubricant well.

ADVANTAGES OF PLUG VALVES

1. Quick Opening.
2. Positive seal on Light Hydrocarbons.
3. Less space than Gate Valves.
4. Available in Three-Way and Four-Way.
5. Can be used with Locking Device.

Jones & Laughlin

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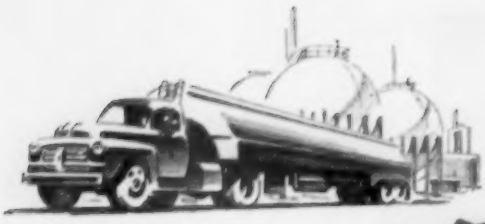

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AN EATON 2-SPEED AXLE
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the right one for every road and load!

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- Less wear on engine and power transmitting parts.
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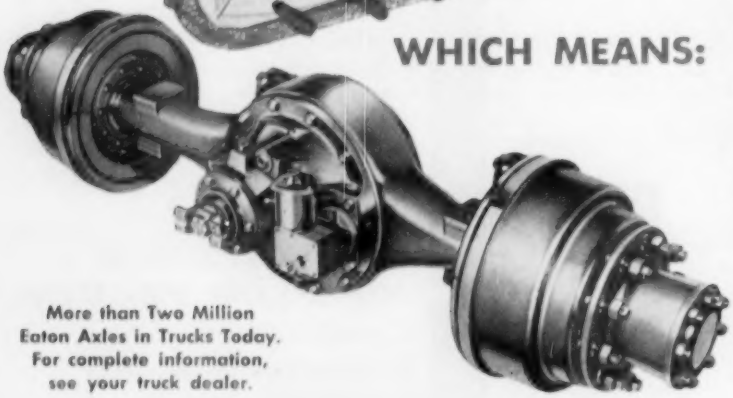
- Easier driving; safer operation.
- Longer truck life; higher trade-in value.



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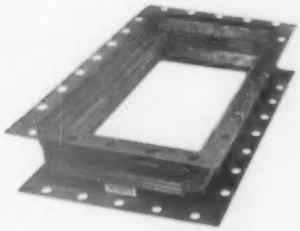
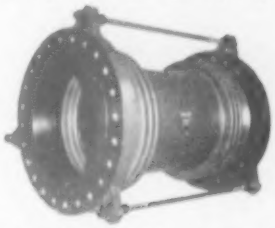
Sola-Flex bellows 

and expansion joints

are made in all sizes

and varieties



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BIG OR LITTLE, round or square, convoluted or U-span—no matter what kind of expansion joints you need, Solar can build them. Sola-Flex joints are durable, economical, and are based on advanced engineering designs using a wide variety of metals. High or low pressure piping problems are easily solved with Sola-Flex bellows. Ask for our latest catalog. Write Dept. C-70, Solar Aircraft Company, San Diego 12, Calif.

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For Petroleum Pumping and Processing

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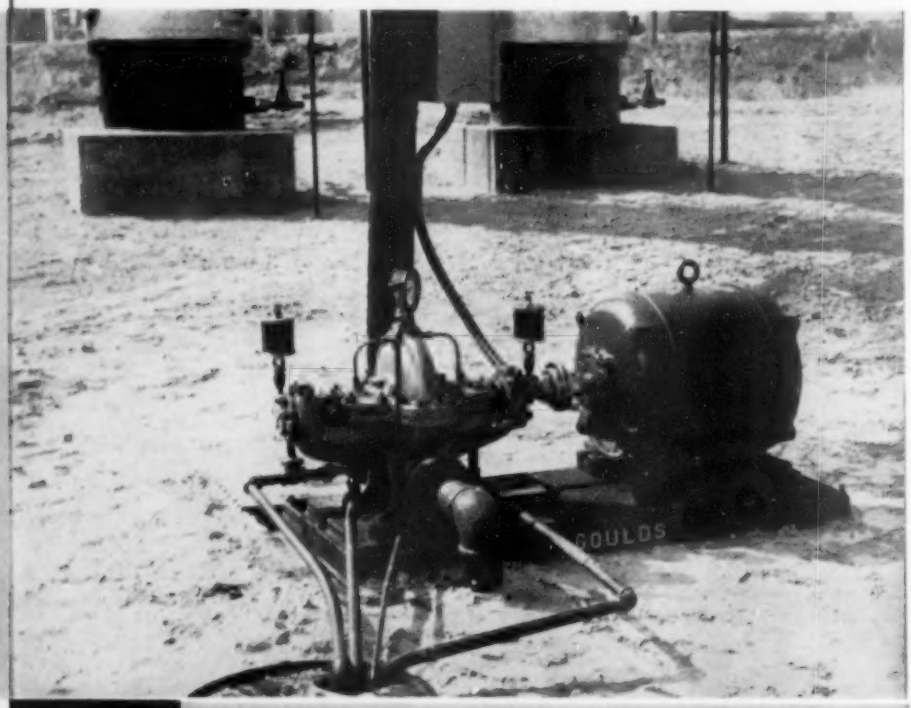
There's a complete line of Century Motors engineered and built to withstand the tough requirements of the oil producing and refining industries.

Performance-Rated Century Motors are available with Weather-Gard frames which protect against rain, snow, sleet and falling objects—and with screens to keep out rodents.

Totally Enclosed and Explosion Proof Types are available for dusty and explosive atmospheres . . . and you have a wide range of choice in starting and running characteristics to meet your needs. Check with your supply store, or Century branch office.

At Kilgore, Texas, this 25 HP Century Motor drives a sump pump at production battery on townsite wells.



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MOTORS
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You are looking ahead toward preventing a probable turn-down of a tank of oil when the first cold snap comes—when you purchase a treater for new production *now* while there is more time for adequate consideration of the exact need. Maloney-Crawford's line of treaters will handle any problem economically whether it involves loose or tight emulsions, heavy foaming oil, or considerable free water.

Large free water sections, generous size furnaces, adequate settling sections, large efficient downcomers feature M-C treaters. Available in horizontal or vertical type; atmospheric or pressure.

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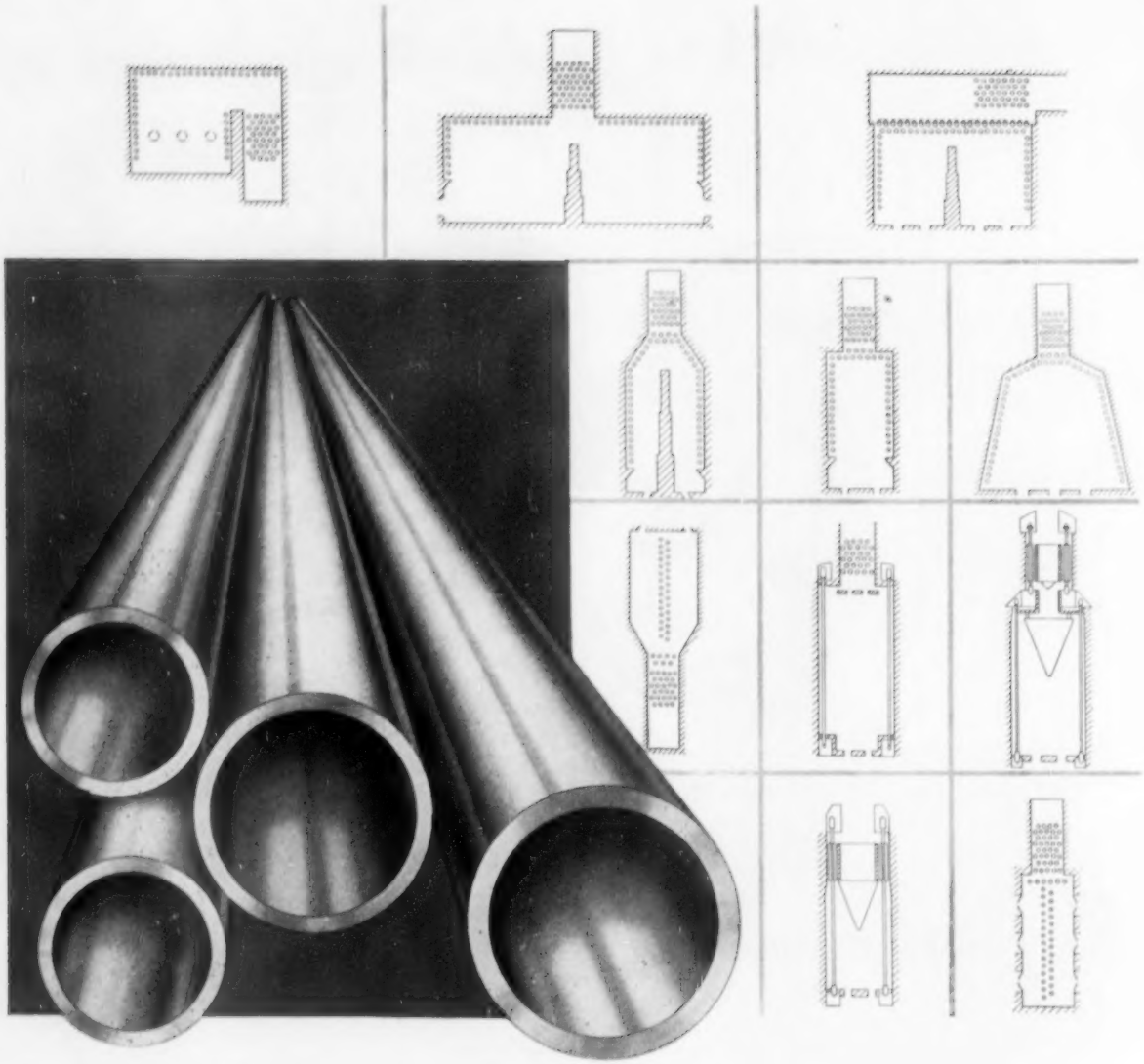

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TA-6062(P)

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WORTHINGTON CORPORATION

BUFFALO, NEW YORK

OFFICE OF THE VICE PRESIDENT

TO: Natural Gas Pipeline Industry

SUBJECT: Worthington's TURBO-UNIFLO SUTC Gas Engine Compressor

Every once in a while a major improvement in gas transmission equipment comes along. The UTC engine compressor, introduced in 1949, was such a development. Designed for smoother running and cooler burning, it had a new and novel uniflow scavenging system which promised to drastically cut fuel and maintenance costs.

The UNIFLO 2-cycle engine won immediate acceptance. One of the "penalties of leadership," however, was the need for related design improvements to keep pace with its advanced scavenging system. These changes have all been applied.

It is out of such pioneering work that great strides are made in the search for more reliable, more economical, progressive pipeline equipment. In addition to the changes you now find in the standard UTC design, our engineers added turbocharging. Unlike ordinary 2-cycle supercharged gas engines, Worthington turbocharging requires no power-draining extra drive from start-up through full load. Successful performance is now proved by over two years of field operating experience on pipeline service.

Extensive research and conclusive shop and field testing of the TURBO-UNIFLO SUTC, as we call our current design, have resulted in improved fuel consumption, greater load flexibility, and lower noise level.

With its uniflow scavenging system, the turbocharged SUTC represents a great advance in compressor station equipment ... one which contributes substantially to reduced cost of pipeline station operation.

Believing that you will want to review the features of the SUTC, we have made a very complete technical bulletin available. You can obtain your copy by requesting S-550-B23D from Section E65, Worthington Corporation, Harrison, N.J.

Any comments would prove of great interest and value to us.

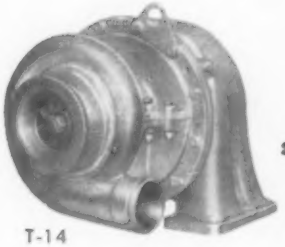
Austin C. Ross

Austin C. Ross, Vice President and General Manager
Compressor and Engine Division

P.S. The SUTC is ideally suited for refinery and process work, too, because of its great flexibility over a wide range of loads, speeds, and variable capacities. The bulletin referred to above also covers these applications.

AiResearch Turbochargers

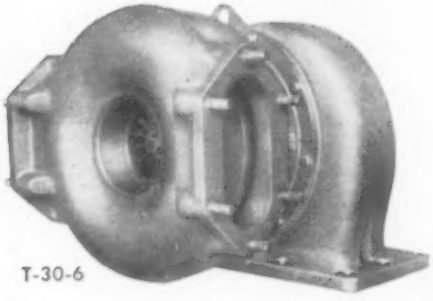
T-10



T-14

These scientifically-engineered turbochargers for your mobile, stationary or marine diesel engines are available now!

T-15



T-30-6

T-30-2

AiResearch has incorporated into the design and manufacture of its turbochargers the greatest experience in the field of small turbomachinery of any company in the world! With these results:

AiResearch turbochargers increase power up to 100%. The only limitation is the design and application of your engine.

Because they *are* air-cooled, they place no extra burden on your cooling system.

They cut fuel costs up to 20%, reduce noise and decrease or completely eliminate diesel smoking.

They're easier to maintain than any other turbochargers. A removable rotating assembly simplifies and reduces maintenance.

They allow your diesels to operate at full efficiency from sea level to more than 8000 feet.

We invite your inquiry on how you can improve the performance of your diesels by the application of AiResearch turbochargers.

BASIC SPECIFICATIONS FOR AIRESEARCH TURBOCHARGERS

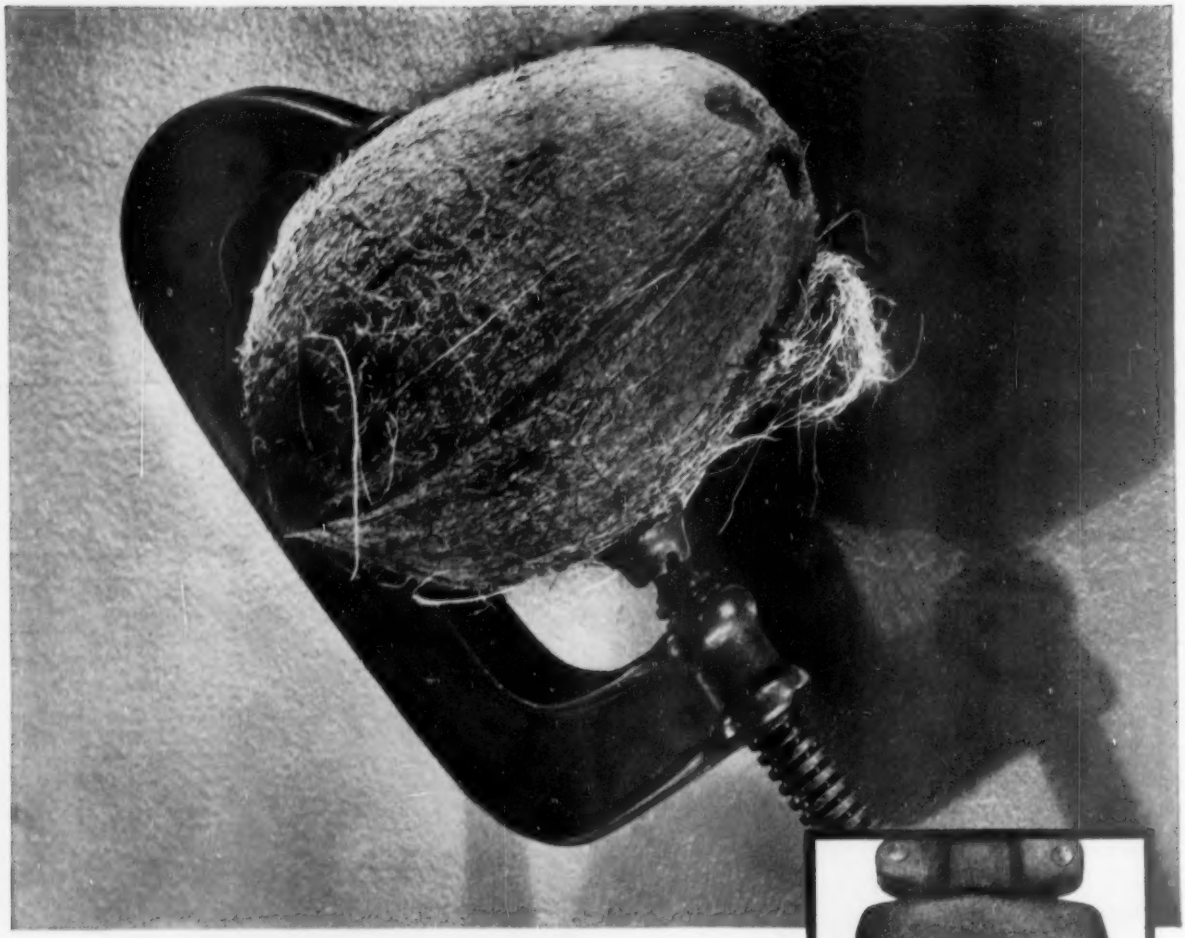
MODEL	T-10	T-14	T-15	T-30-2	T-30-6
Diameter — in. nom.	9	11.5	15.25	15.25	16
Length — in.	9	14.12	16.75	17.25	21.75
Weight — lb.	40	95	125	135	195
Output — lb/min. (Standard Conditions)	25-40	35-65	35-65	70-95	115-175

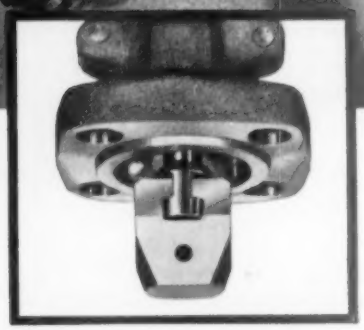
THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

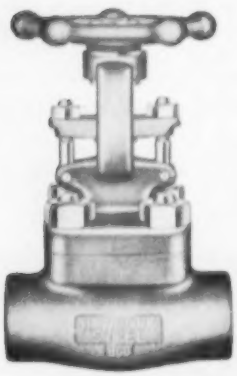
DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS





STAMINA

that takes heavy loading



THE STEM-WEDGE CONNECTION in Type 950 Hancock Steel Gate Valve won't bend or fracture even if corrosion prevents opening the valve. So strong is the connection that destructive "cheater" loading on the handwheel will first break the stem thread. The operator thus knows that the valve is still closed and can act to safeguard equipment and avoid shutdowns.

This ultra-strong stem-wedge connection, *an exclusive Hancock design*, overcomes a structural weakness widely recognized in other small gate valves. Its balanced design also places the "T" head slot in the wedge so that the stem can move freely, even though flow forces the wedge against the guides. It is a powerful example of the quality that makes Type 950 Hancock Steel Gate Valves perform better and longer in the severest services. Call your Industrial Supply Distributor for full details today.

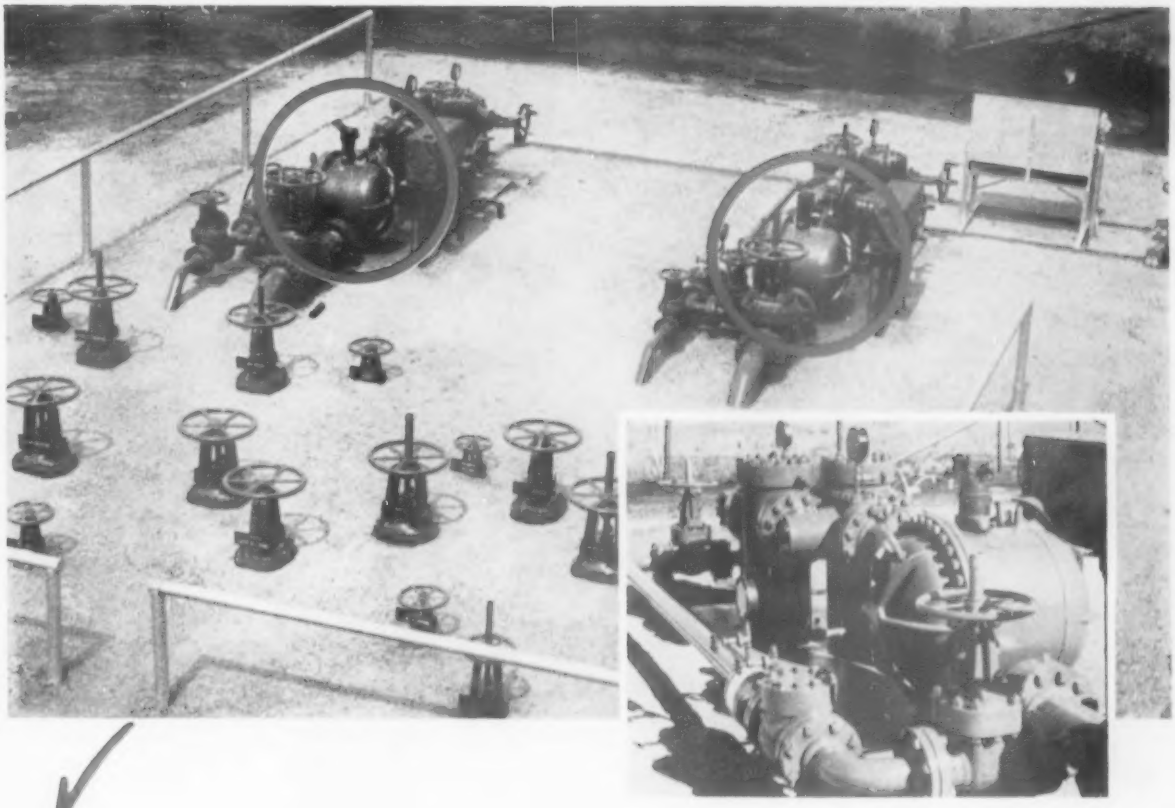
HANCOCK VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Watertown 72, Massachusetts

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



Pipeline deliveries of crude to the refinery are measured by Brodie BiRotor Meters

This meter application simplifies control, provides accurate delivery records, offers savings on operating costs, and reduces tankage as deliveries can be metered direct to a working tank.

Tidewater Oil Company's recent installation at the Nichols, California Station, meters crudes in lines feeding their Avon Refinery. The photographs above show two Brodie BiRotor Meters, each capable of handling 1800 bbls/hr.

In this type of service, calling for 'round-the-clock dependability year in and year out, the sustained accuracy, low maintenance requirements, and safety of double-case construction offered by Brodie BiRotor Meters are of primary importance.

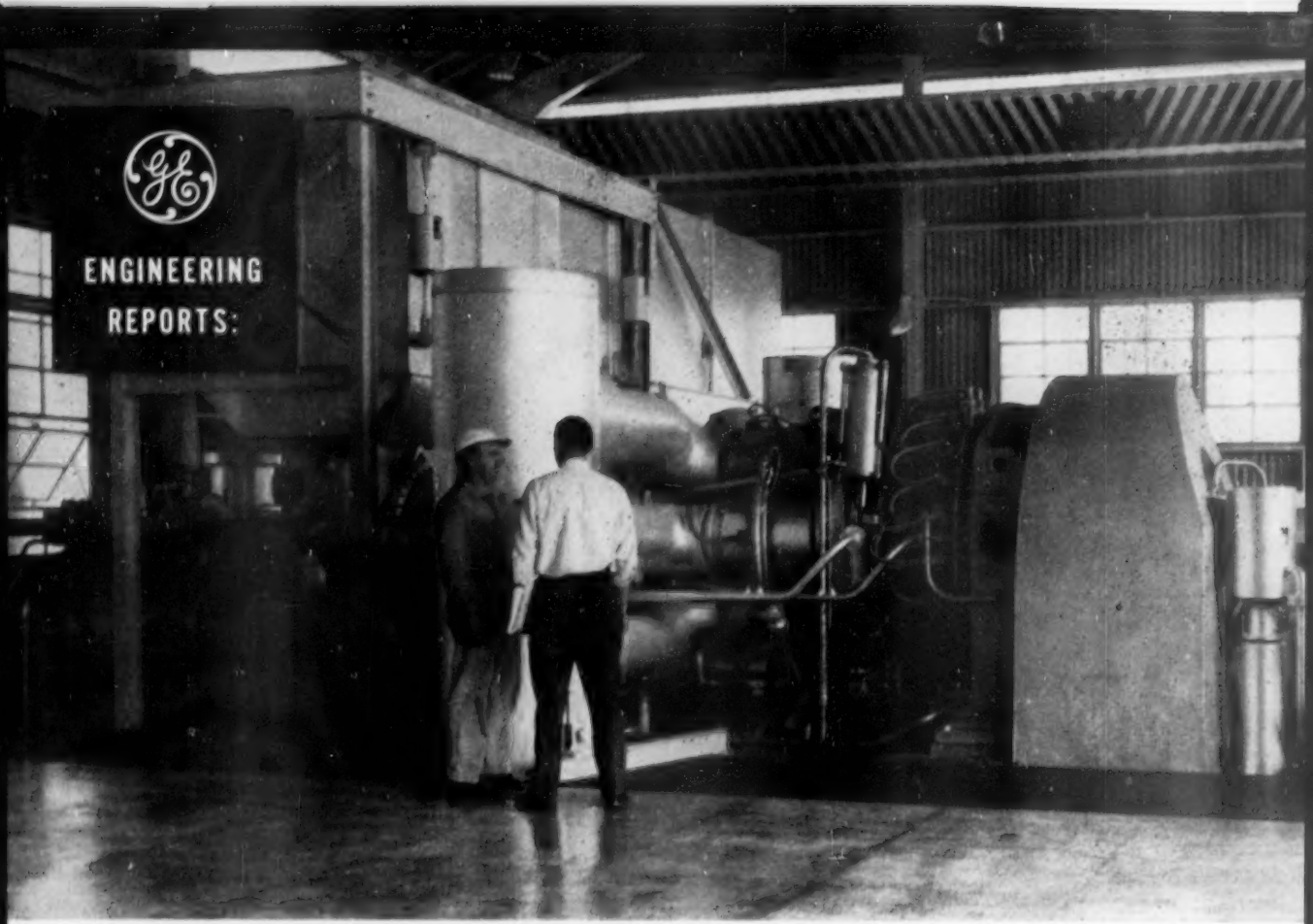
Whatever your pipeline metering problems, get full details on Brodie BiRotor Meters.

BRODIE ALL-STEEL BiRotor TRUE ROTARY **METERS**

RALPH N. BRODIE COMPANY · San Leandro, California, U.S.A.

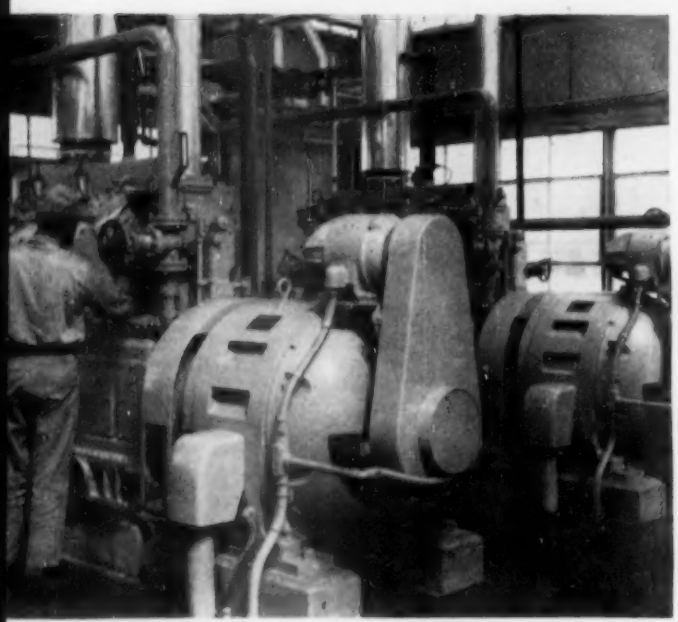
MT. VERNON, N. Y.	DALLAS 2, TEXAS	CHICAGO OFFICE:	SEATTLE 9, WASH.	LOS ANGELES 22, CALIF.
550 So. Columbus Ave.	167 Parkhouse St.	1227 Circle Ave., Forest Park, Ill.	221 9th Ave. N.	5401 E. Sheila Street

REPRESENTATIVES WITH STOCKS AND SERVICE FACILITIES IN ALL PRINCIPAL CITIES

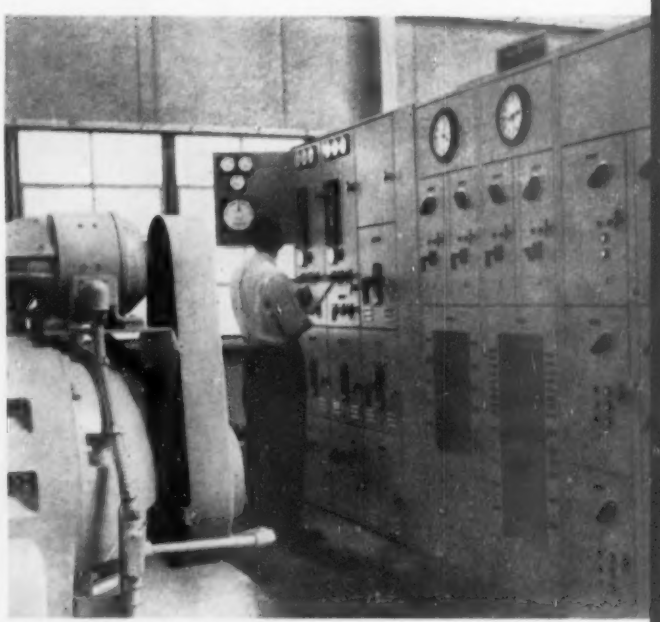


Powered by General Electric engineered drive system . . .

Tennessee Gas Transmission uses parallel

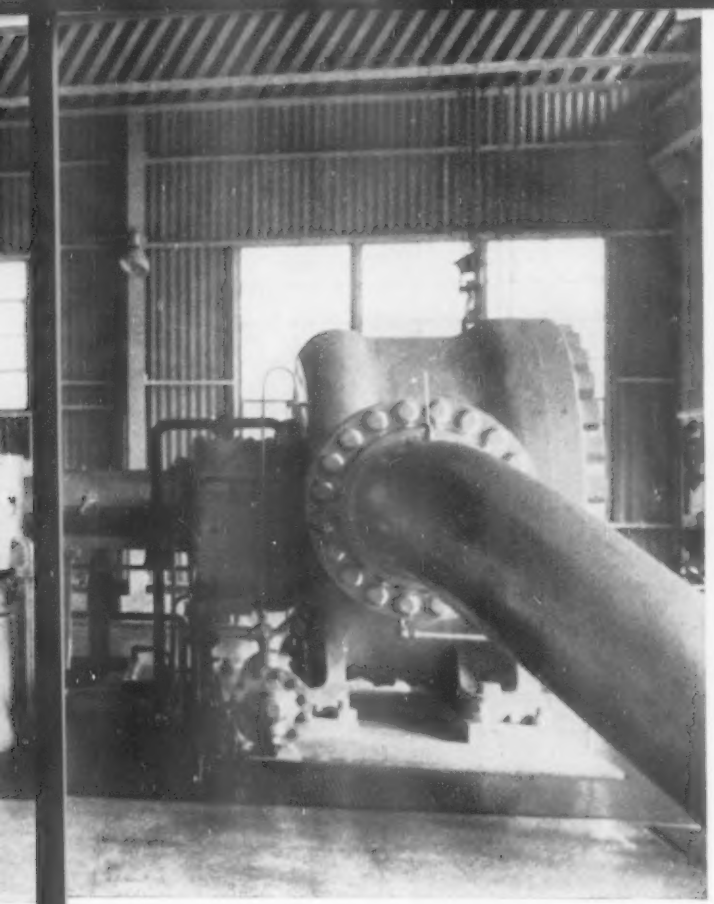


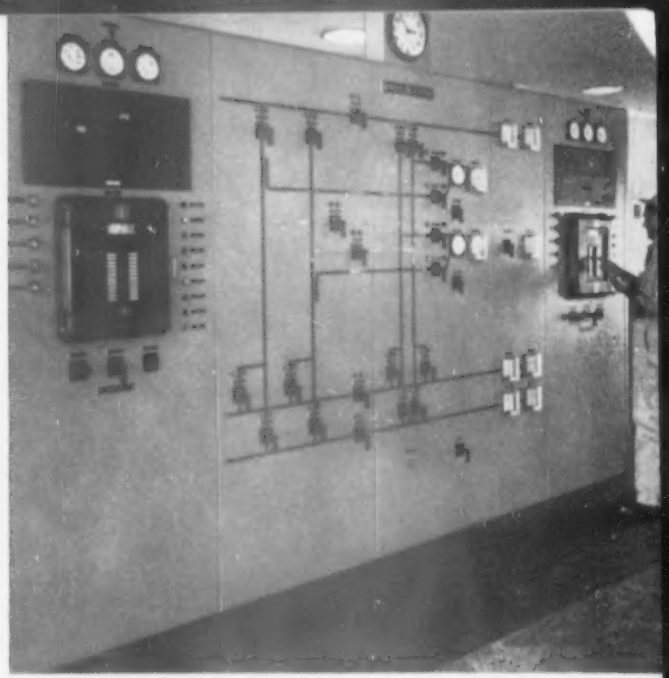
AUXILIARY ELECTRICAL equipment receive power from two General Electric 187-kva, engine-driven, a-c generators which supply 480-volt, 60-cycle power for the station system.



COMPACT, FACTORY ASSEMBLED General Electric Cabinetrol* panel centralizes control of station's auxiliary equipment, was planned to take up minimum valuable floor space.

*Reg. trade-mark of General Electric Co.

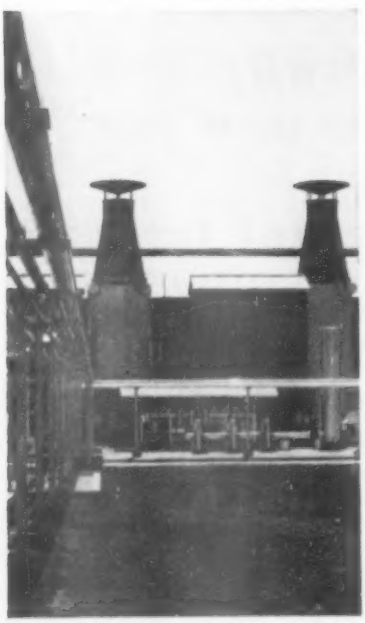




CENTRALIZED CONTROL for the 2 General Electric gas turbines is located in accessible, duplex control panel. Panel provides semi-automatic operation, requires little supervision.

PARALLEL COMPRESSOR ARRANGEMENT, first in the industry, permits two 6700-hp gas turbines to handle station's prime mover requirements for 4-season, lower cost operation.

compressor arrangement in Morehead station



TURBINE EFFICIENCY is increased with regenerators, located outside new station, that "recapture" exhaust heat.

General Electric engineered compressor drive system, with two 6700-hp gas turbines, helps lower new station's operating costs

The Tennessee Gas Transmission Company's new Morehead, Kentucky, pipeline station has two centrifugal compressors arranged for parallel flow, to provide highly flexible operation. With this arrangement—an industry first—the adjustable speed compressors provide a wide range of flows and piping combinations with high stability.

THE DRIVE SYSTEM was installed to meet the station's individual compression requirements and to help lower operating costs. Speed adjustment of the turbines, to meet seasonal increases in compressor load, is easily accomplished. The station has lower maintenance and operator requirements. In addition, the gas turbine fundamental characteristic of increasing horsepower, with decreasing ambient temperature, means that up to 25% more horsepower is available to meet cold weather's increased load requirements.

WHEN YOU EXPAND your compressor facilities, General Electric has a complete line of engineering services also available to you, to help you and your consultants install a drive system engineered for your particular requirements. Your Apparatus Sales Representative, at the nearest General Electric Apparatus Sales Office, will give you complete information. Contact him early and write for bulletin GEA-5962 to General Electric Co., Section 661-54, Schenectady, N. Y.

Engineered Electrical Systems for Pipeline Pumping

GENERAL ELECTRIC

CF&I WICKWIRE ROPE A CF&I PRODUCT

Your Wickwire Rope Distributor and our metallurgist... work together for you

This metallurgist—who is responsible for the quality of our rope wire—is with your Wickwire Distributor every time he makes a call.

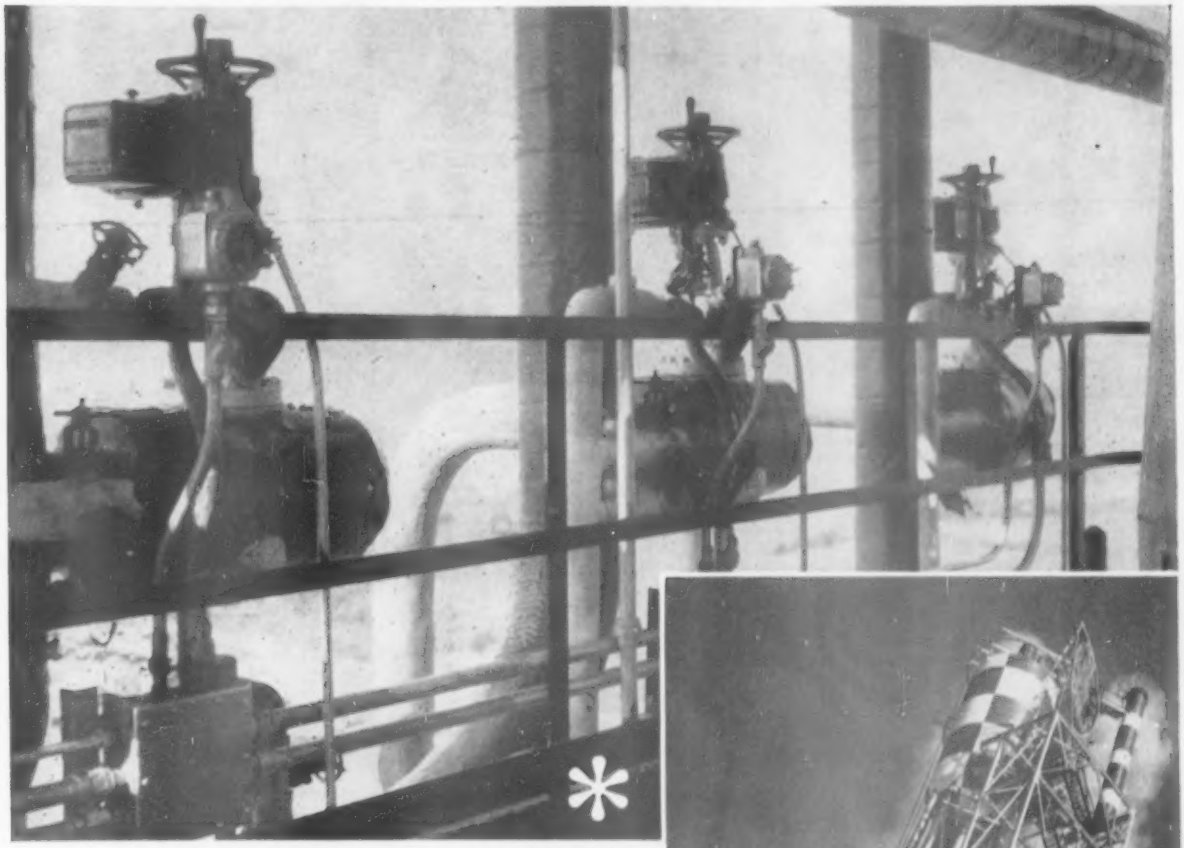
True, he's physically in his laboratory, supervising the thorough testing *of both ends of every coil* of wire to assure uniformity throughout the coil. But, whenever your Wickwire Distributor calls, he has the full assurance that metallurgists like this are constantly making sure that the product has the right chemical and physical properties to give long, dependable service.

It's just one more reason why your Wickwire Distributor knows he's got top-quality wire rope, slings and strand to sell . . . and that these products will serve you well.

4084

A PRODUCT OF THE COLORADO FUEL AND IRON CORPORATION

Push-Button Control *FOR* PETROFINA'S NEW 16,000 BPD PLANT



...where dependability counts—the choice is

LimiTorque®

LimiTorque valve controls provide truly *automatic* operation for catalyst return pipe valves on Canadian Petrofina's newest Houdriflow Catalytic Cracker. This giant unit provides the major portion of high-octane gasolines at the Montreal refinery.

LimiTorque operates at the mere "push of a button," saving time, labor, and money as compared to expensive, time consuming manual operation of valves at distant or inaccessible locations. LimiTorque opens and closes valves at the exact speed required. It also "limits the torque" applied to valve operating parts, preventing possible damage to valve stems, seats and discs.

LimiTorque may be actuated by any available power source, including Electricity, Oil, Gas, Water or Air, and is now available for Microwave control.

For the full story on LimiTorque, please request Catalog L-550.

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

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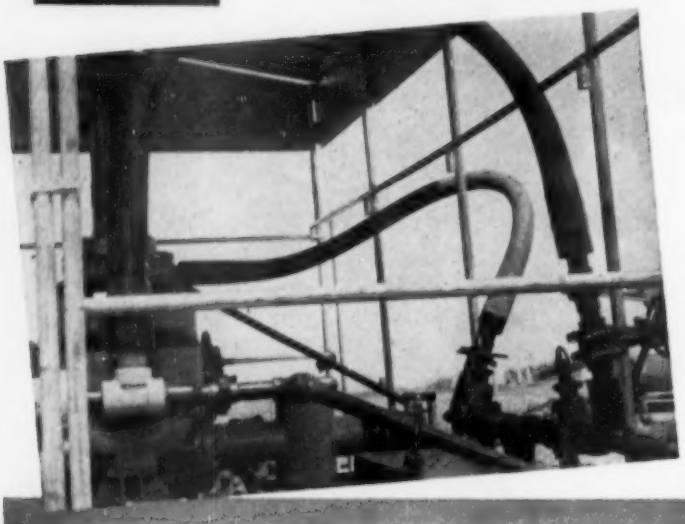
HERE'S WHY J&L STORES STOCK REPUBLIC HOSE



1. You, the customer, demand the best hose . . . so J & L stocks Republic Hose.
2. You, the customer, demand service . . . so J & L stocks Republic Hose.
3. You, the customer, demand the right hose for the specific application . . . so J & L stocks several kinds of Republic Hose.

When you need the right hose, quick, call your closest J & L store listed below.

LOOK FOR REPUBLIC HOSE AT THESE J & L STORES

ARKANSAS
El Dorado

COLORADO
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Carmi, Clay City, Salem, St. Elmo

KANSAS
Chase, El Dorado, Great Bend, Hill City, McPherson, Russell, Winfield

KENTUCKY
Henderson, Paintsville

LOUISIANA
Bunkie, Harvey, Haynesville, Houma, Lafayette, Lake Charles, Rodessa, Shreveport

MICHIGAN
Mt. Pleasant

MISSISSIPPI
Brookhaven, Laurel, Natchez, Oil City

MONTANA
Cut Bank, Glendive

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Alice, Anson, Ballinger, Beaumont, Best, Big Spring, Borger, Corpus Christi, Electra, Freer, Gladewater, Graham, Houston, Kermit, Kilgore, Longview, Luling, Mexia, Midland, Muenster, Odessa, Overton, Pampa, Pleaston, Sherman, Snyder, Sundown, Talco, Victoria, Wichita Falls

WEST VIRGINIA
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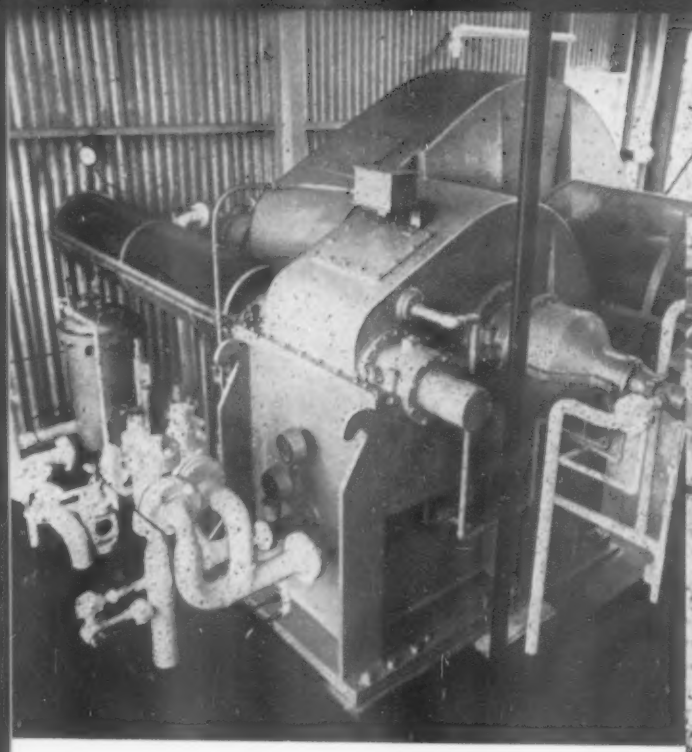
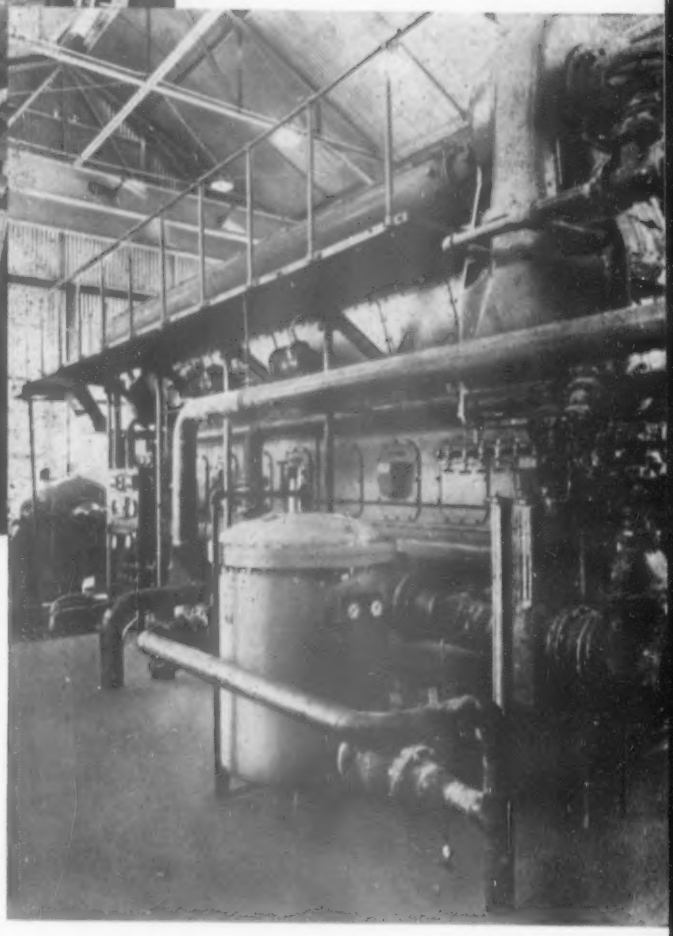
WYOMING
Casper, Newcastle, Powell, Worland

Stocked in the Mid-Continent Area by JONES & LAUGHLIN SUPPLY DIVISION P.O. Drawer 2481, Tulsa 2, Okla. and the J & L Store in YOUR field

REPUBLIC RUBBER DIVISION
LEE RUBBER & TIRE CORPORATION, YOUNGSTOWN 1, OHIO
INDUSTRIAL RUBBER PRODUCTS

Stocked on the West Coast by HENDRIE BELTING & RUBBER CO. 405 Towne Ave., Los Angeles, Calif. PACIFIC COAST RUBBER COMPANY 51 Main St., San Francisco, Calif.





"Satellite" pipeline station, remotely controlled, uses Western Gear two-stage high speed drive

REMOTE CONTROL operation from a point many miles away is a notable feature of the isolated Gulf-Interstate Gas Company's gas line pumping station near Stanton, Kentucky. Another modern feature is its two-stage high speed unit especially designed and manufactured by Western Gear, shown at upper left. This "custom-engineered" unit is driven by a Cooper-Bessemer 16-cylinder engine operating on natural gas from the pipeline. The engine speed of 360 RPM is stepped up by the high speed unit with a ratio of 16.8:1 driving the centrifugal compressor at 6,055 RPM. The entire pipeline station can be placed into operation and completely controlled by a telemetering system miles away.

Pipeline experts consider this station one of the most modern and advanced systems of its kind to date. Western Gear's long experience, dating back to 1888, made it the logical choice to design and build the high speed unit so essential to efficient performance of this significant installation. This experience is always available and Western Gear engineers are glad to help solve any problem involving mechanical power transmission equipment for the petroleum industry. Write General Offices, Western Gear Corporation, P.O. Box 182, Lynwood, California.

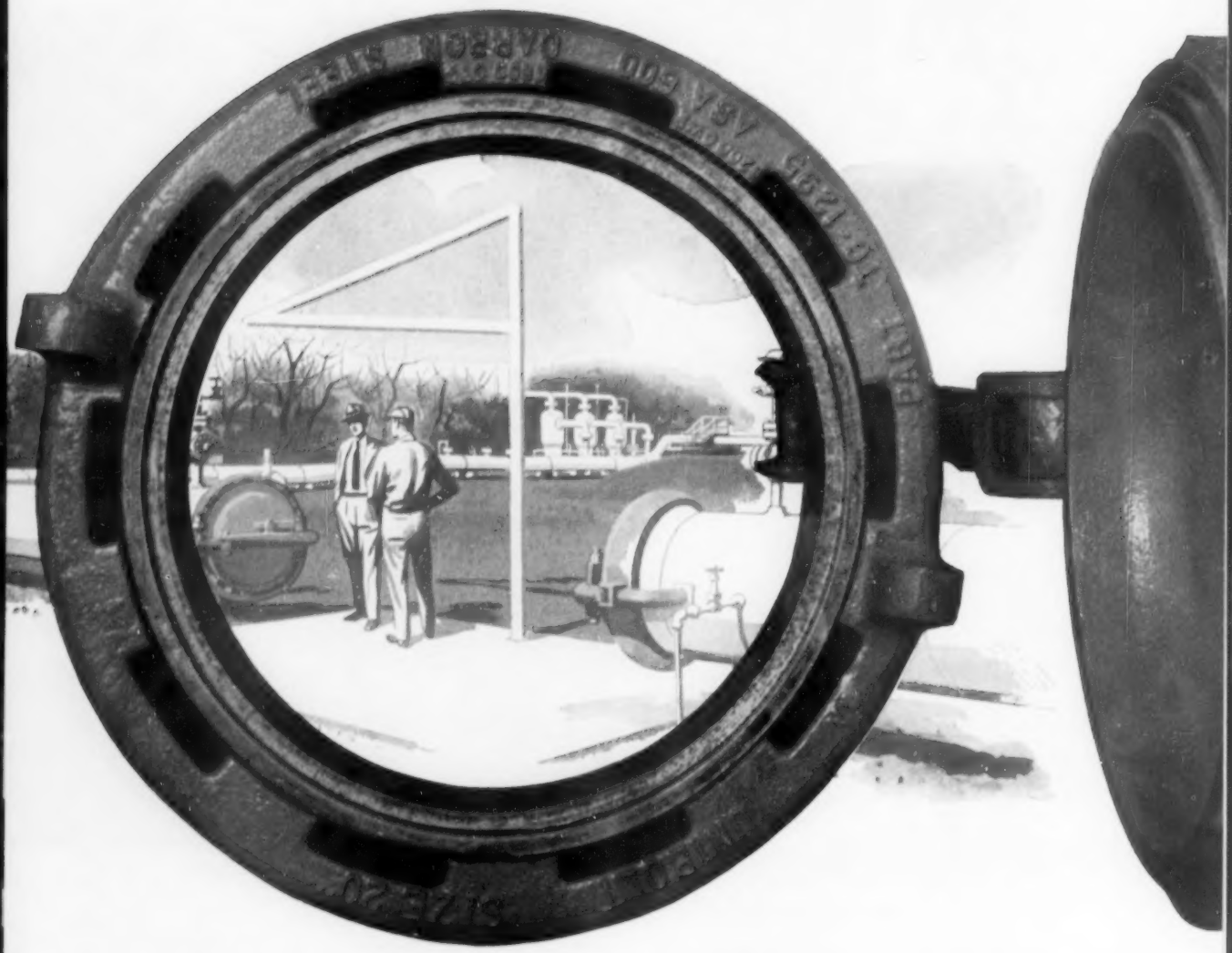
"The difference is reliability" • Since 1888

5604

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON
REPRESENTATIVES IN PRINCIPAL CITIES

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

THE MODERN VIEWPOINT ON SCRAPER TRAPS



SELF-SEALING GASKET — made of Hycar (oil and gas resistant rubber) — is the final answer to scraper trap leaks. Its lipped design makes it self-sealing under line pressure. The coupling cannot be over-tightened to the extent of damaging the gasket or the coupling itself.

UNIBOLT

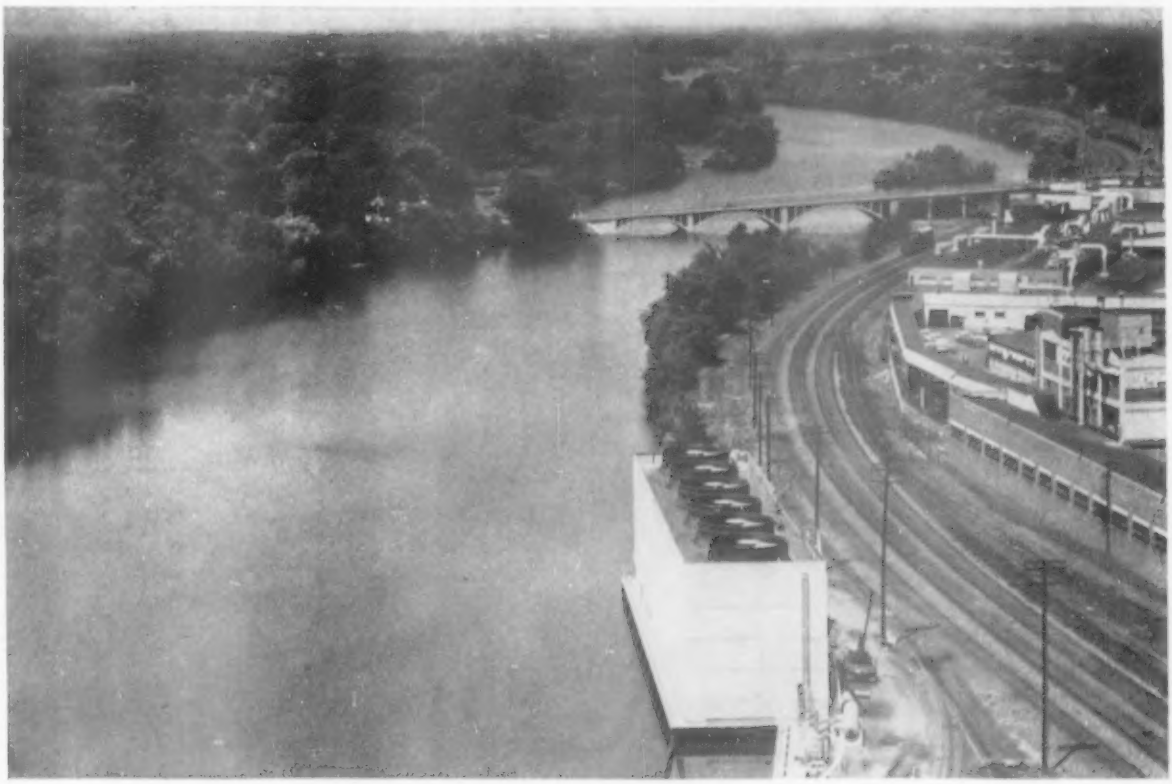
No threads to gall or freeze . . . No leaky seals . . . No doubt about strength — it conforms to all codes . . . No multi-bolt flanges.

Release two bolts. Swing the trap open. Take the pig out or put the pig in. Close the trap and tighten two bolts. That's just how simple and easy it is to operate a UNIBOLT Scraper Trap. An over-size barrel (slightly larger than the o. d. of the pig) makes it equally easy to start a pig. Line pressure does the heavy work.

Pipeliners everywhere are using UNIBOLT closures and couplings for scraper traps, blowdowns, strainers, mist removers and other large diameter pressure vessels.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

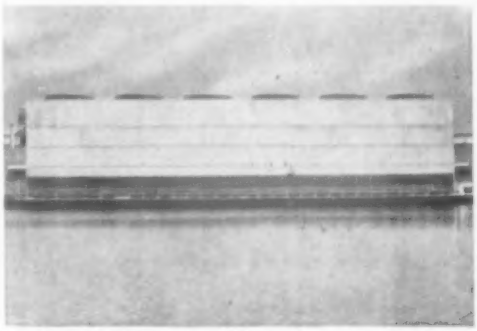
COOLING TOWER
Cooling a River? . . . Yes!



THE Board of Water and Electric Light Commissioners, Lansing, Michigan required 32,000 GPM additional circulating water capacity in order to add a new steam electric generating unit at the Moores Park Station. River flow during the summer months was insufficient, however, to meet the requirements of this rapidly growing load. A cooling tower installation proved the economic solution, in preference to relocating the new generating facilities. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

Pleasing architectural appearance of the tower was also an important consideration because of a municipal park across the river.

A Foster Wheeler six cell induced draft tower with cement asbestos board casing and stainless steel trim was chosen for this unusual installation.

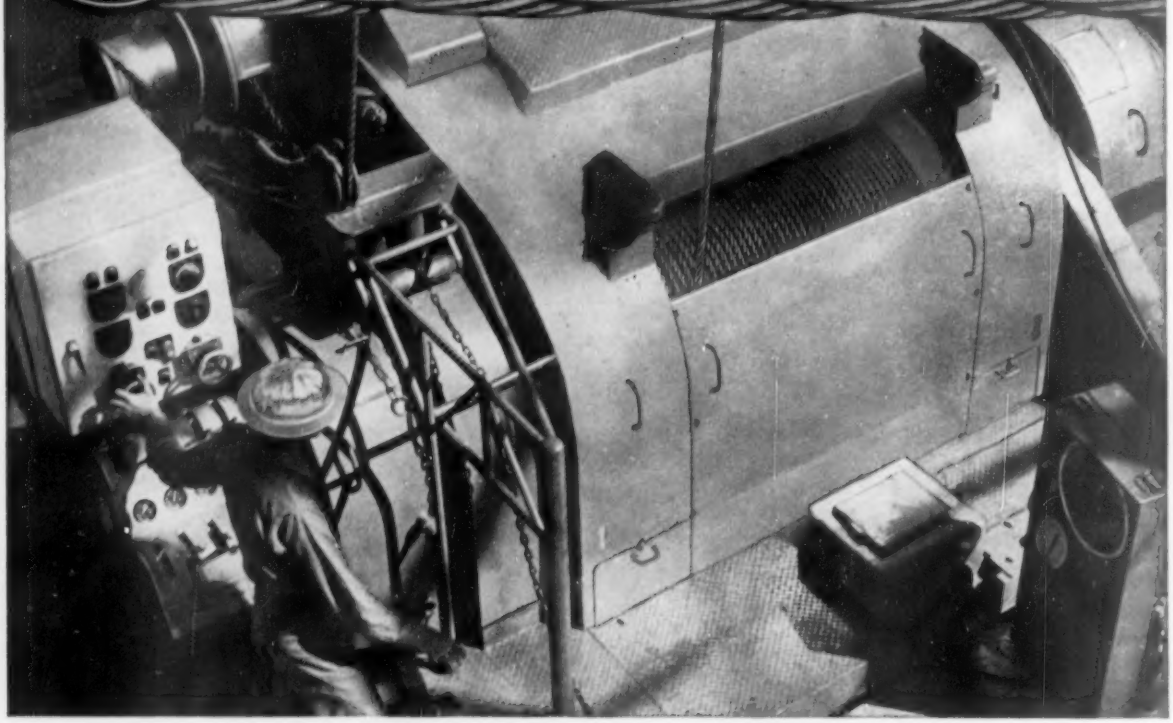


FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

an ACCO product

American Cable TRU-LAY VHS | 15% STRONGER



Drill Deeper and Faster with New VHS Rotary Drilling Lines

Drillers in every part of the oil country are proving to themselves the benefits of new VHS Rotary Drilling Lines. Made of a new grade of steel for wire rope, these new VHS lines are 15% stronger than Improved Plow Steel—the strongest available up to now. The new VHS is tougher, too. It gives you many important advantages, including:

Higher Factor of Safety

Careful calculations show that the factor of safety for 10 lines of TRU-LAY VHS rope is 14.9% or 15% higher than for 10 lines of IPS rope. To say it another way, the factor of safety for 12 lines IPS is almost identical to 10 lines of VHS rope. This alone would be reason enough to order VHS rope.

Faster Drilling—Less "Down Time"

With new VHS, you can drill deeper before increasing the number of parts of line. And VHS's extra strength eliminates, in many cases, any necessity for buying new blocks or regrooving sheaves to use larger diameter lines for higher safety factors.

Tougher

Because TRU-LAY VHS is stronger *and* tougher, it has greater resistance to abrasion and higher resistance to peening . . . both important factors in maintaining shape and diameter. Ton-mile advantages should result if regular adaptable cut-off practices are followed.

Simple Ordering Procedure

Nothing could be simpler than ordering VHS Rotary Drilling Lines. Just ask your nearest Mid-Continent Supply store for a new VHS drilling line in the length and diameter you need.

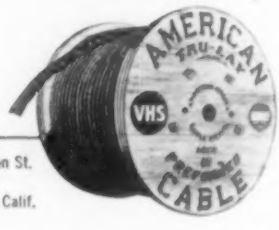
For further information write to the nearest American Chain & Cable Company office listed at right for
Brochure DH-516H

ACCO

American Cable Division
AMERICAN CHAIN & CABLE

630 McFarland St., Houston 1, Texas | 4555 E. 46th Ave., Denver 16, Colorado | 2216 S. Garfield Ave., Los Angeles 22, Calif. | 400 W. Madison St., Chicago 6, Ill.

Wilkes-Barre, Pa.; Odessa, Texas; New York, N.Y.; Philadelphia, Pa.; San Francisco, Calif.



NOW...30 HP!

NEW FUEL ECONOMY

FASTER STARTING

STALL-PROOF IDLING

NINE GREAT MOTORS

*JAVELIN	30 hp	$582.00
*SEA-HORSE 30	30 hp	532.00
SEA-HORSE 30	30 hp	462.00
*SEA-HORSE 15	15 hp	452.00
SEA-HORSE 15	15 hp	362.00
SEA-HORSE 10	10 hp	321.00
SEA-HORSE 7½	7½ hp	241.00
SEA-HORSE 5½	5½ hp	216.00
SEA-HORSE 3	3 hp	146.00

**Electric Starting...Prices f.o.b. factory, subject to change...OBC certified brake hp at 4000 rpm (30's at 4500 rpm).*

FOR 1956: Johnson presents NINE Sea-Horses . . . 3 to 30 hp! Featuring new fuel economy. Quicker, smoother starting than ever before. New Stall-Proof Idling. Electric and manual starting. Remote Control fittings for steering, shift, and throttle. *And traditional Johnson DEPENDABILITY.* All models are beautifully styled in Johnson's new Holiday Bronze and Spray White.

FREE! The new Sea-Horse Catalog gives the full story on all that's new for '56. New models, new features. New power and load-carrying ability. Write . . .

JOHNSON MOTORS, 6600 Pershing Road, Waukegan, Illinois

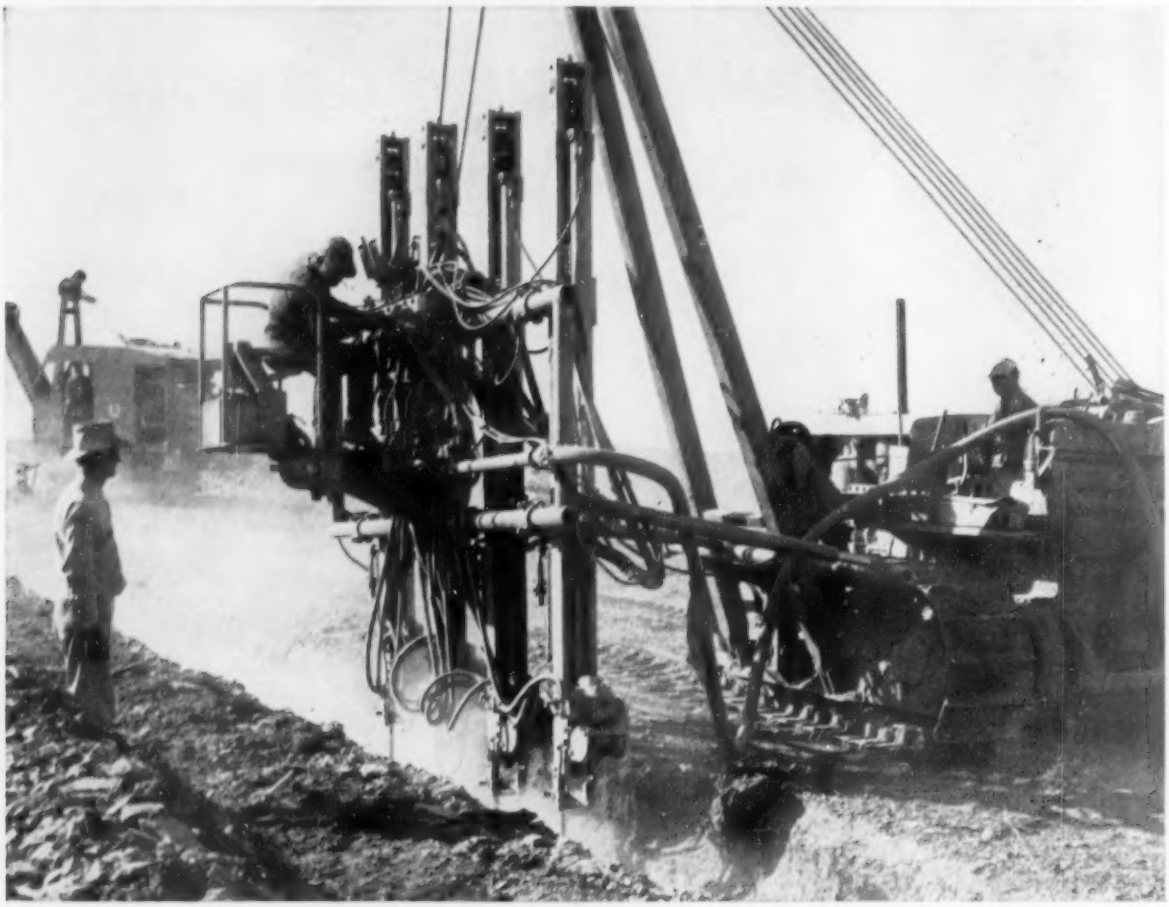
A DIVISION OF OUTBOARD MARINE & MANUFACTURING COMPANY

In Canada: Manufactured by Johnson Motors, Peterborough

Johnson SEA-HORSES FOR DEPENDABILITY

ALL JOHNSON SEA-HORSES ARE PROTECTED AGAINST SALT WATER CORROSION—NO FLUSHING NECESSARY

Gardner-Denver . . . Serving the World's Basic Industries



One man does the work of four with the new Gardner-Denver Quad-dril

Four fast-acting, heavy-duty rock drills sink four holes at one time. One man controls all drilling operations, through Gardner-Denver remote hydraulic drill controls. Steps along lively, saves time, man-hours and money. Powered by Gardner-Denver Rotary 600 Portables towed behind the tractor. Get all the facts today!

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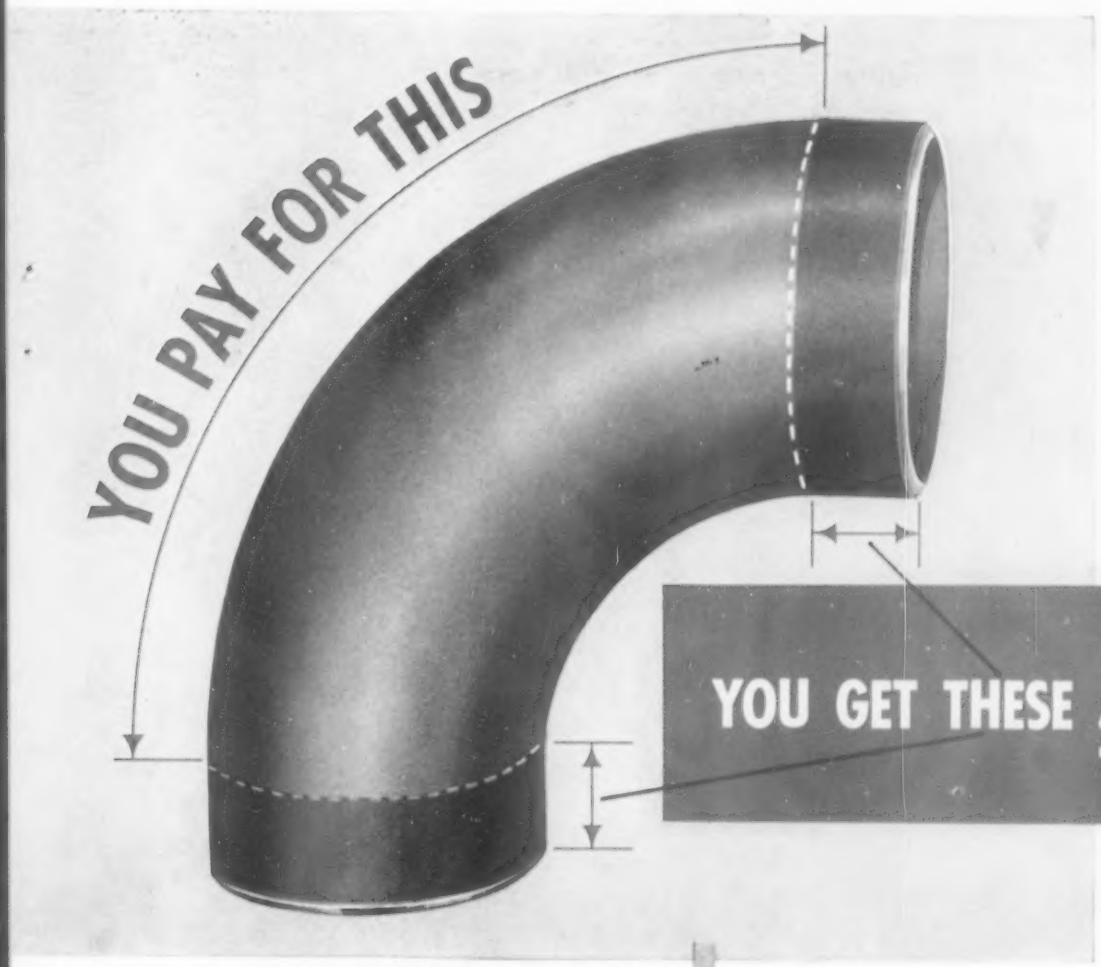
MIDWEST "LONG TANGENT" ELBOWS



In no other welding elbow do you get this "bonus" of long tangents. The dotted lines show where standard elbows end. Each shaded straight end equals ¼ of the nominal fitting diameter . . . a 12" Midwest "Long Tangent" Elbow has tangents 3" long. As a result of the advantages listed at the right, substantial savings are made on many piping systems by using Midwest "Long Tangent" Elbows . . . which cost no more than other elbows. For further information, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Clifton, N. J., and Los Angeles

Sales Offices:
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ADVANTAGES OF MIDWEST "LONG TANGENT" ELBOWS

- ★ They save pipe.
- ★ They often eliminate short nipples and their extra welds.
- ★ They save time and money in lining up and clamping pipe and fitting.
- ★ They make it easier to apply slip-on flanges.
- ★ They remove the circumferential weld from point of maximum stress and can be sleeved.
- ★ THEY COST NO MORE THAN OTHER ELBOWS

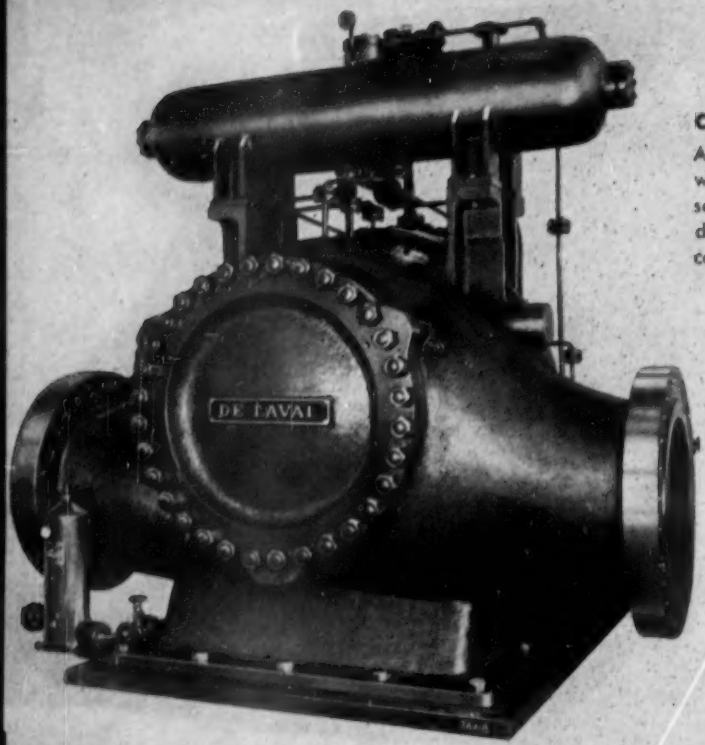
MIDWEST HAS THE MOST COMPLETE LINE

7325

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

DE LAVAL
CENTRIFUGAL PIPELINE COMPRESSORS

come in two "packages" for easy installation

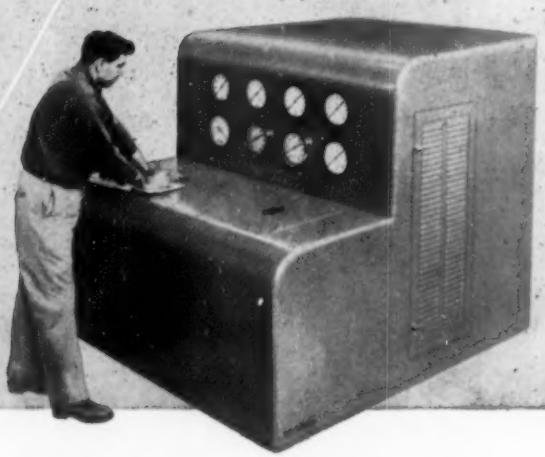


COMPRESSOR

A De Laval compressor with its emergency seal tank mounted directly on the compressor.

CONSOLE

The console contains the filters, motor-driven pumps, coolers, pressure switches, gauges and other accessories. It eliminates complicated piping on the packaged compressor . . . also serves as a protective cover for the equipment it houses.



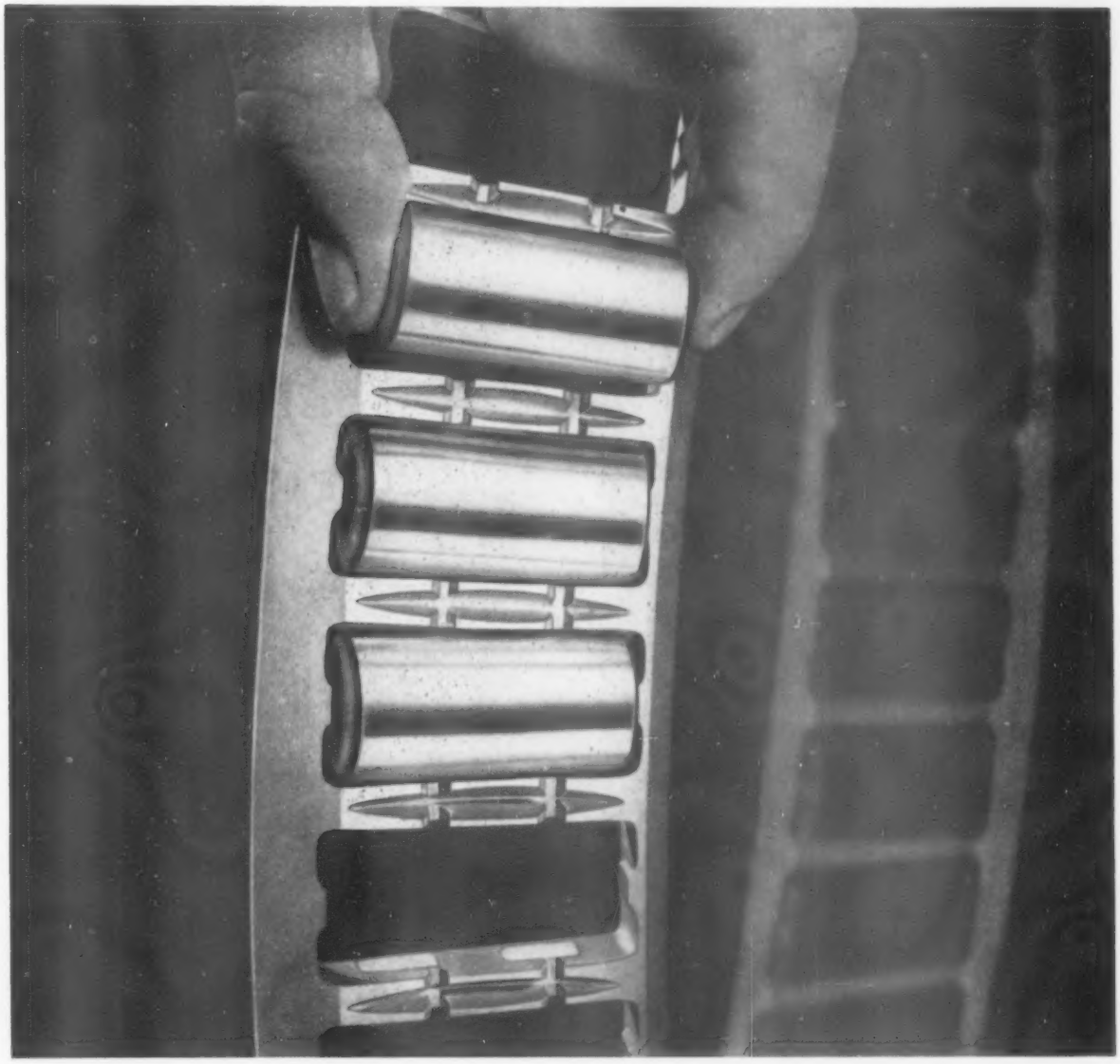
Bulletin 503 gives data on De Laval centrifugal pipeline compressors. Write for your copy.

Designed in two packages, rugged De Laval centrifugal compressors offer many important engineering features. Among these are • high pressure contact shaft seal which eliminates gas leakage • heavy and rigid construction throughout • high load carrying capacity. The compressor and console arrangement makes De Laval centrifugal compressors easy to install—only simple low-cost foundations are required. De Laval units, totaling more than 280,000 horsepower, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
810 Nottingham Way, Trenton 2, New Jersey

TORRINGTON *TAPERED ROLLER* BEARINGS



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The one-piece, cast-bronze cage you see above is one of the reasons why TORRINGTON Roller Bearings give long, low-cost service. Note the individual roller retainment, for example. This helps keep the rollers thoroughly lubricated at all times. Race surface inspection is simplified. The machined pads in each roller pocket make sure the rollers are guided accurately at the pitch line. All this to minimize wear . . . lengthen bearing life.

Yes, TORRINGTON Roller Bearings cut your costs. They're made of the finest bearing quality steel available, heat treated by the most modern methods. No wonder they're so rugged . . . so dependable. Specify TORRINGTON *Tapered* or *Cylindrical* Roller Bearings for heavy loads and low maintenance.

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FOR
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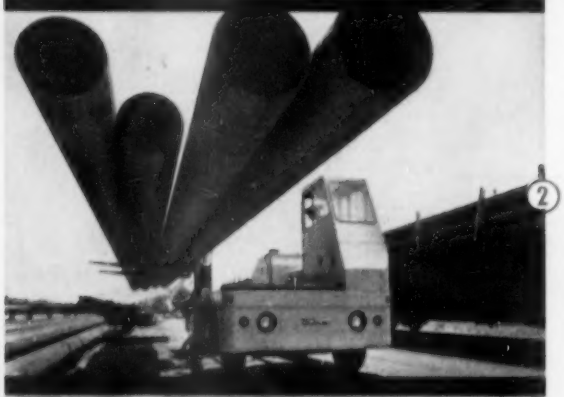

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Vickers Hydraulic Systems make vital contributions to the efficient operation of an extremely wide range of vehicles. To the inherent advantages of hydraulic control, Vickers adds the benefits of a nation-wide and full time field engineering and service organization of unequaled experience. Vickers has the complete line of hydraulic equipment necessary to take undivided system responsibility . . . to eliminate any risk of incompatibility of hydraulic components. Ask for a copy of Bulletin M5101.

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In addition to power steering, Vickers Oil Hydraulics provide fast, smooth and positive (a) turntable rotation, (b) boom elevation, (c) raising and lowering of load, (d) extending and retracting of boom.

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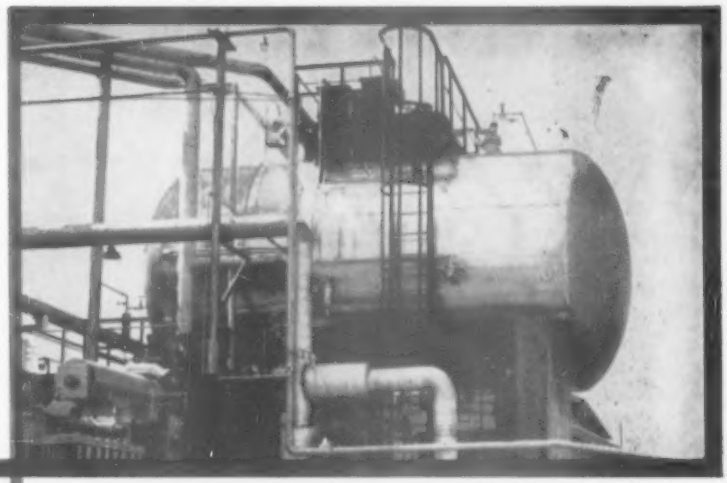

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×	MULTIPLY	your total unit throughput and refining profits.

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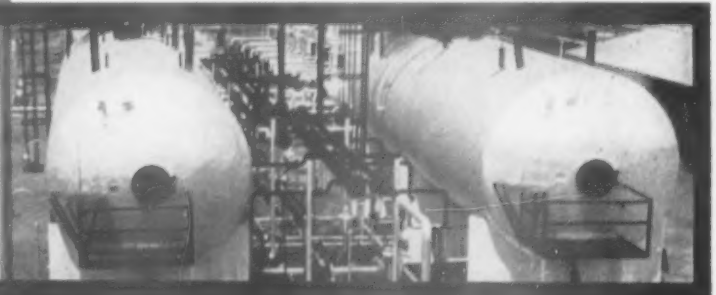

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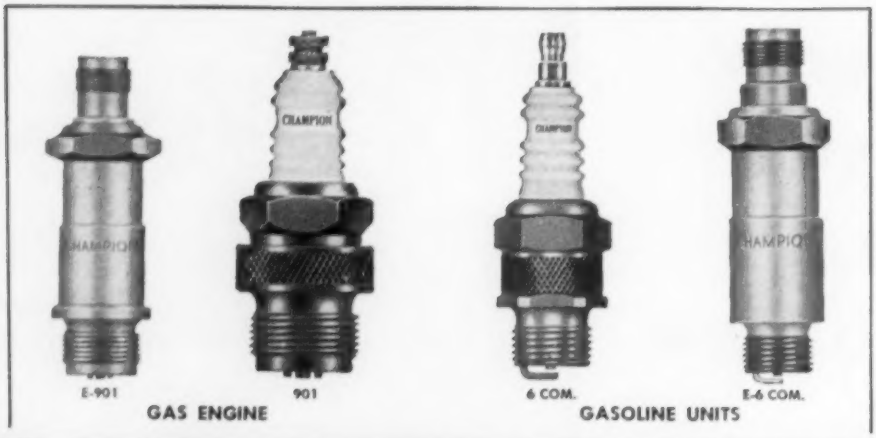

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in every industrial
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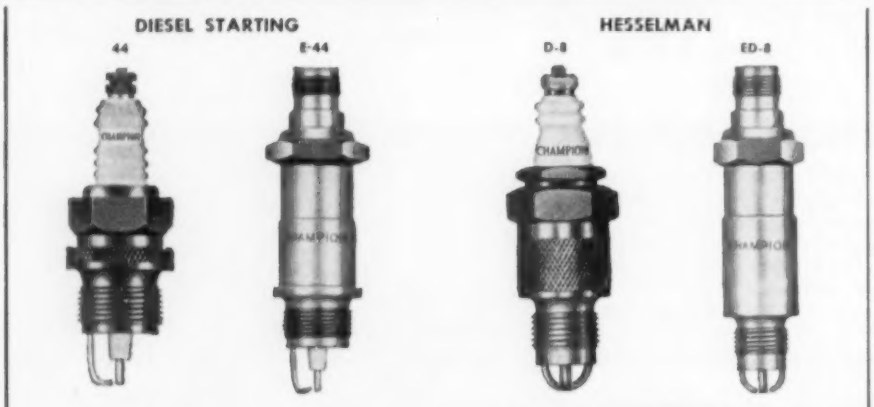
specify dependable
CHAMPION SPARK PLUGS!



BEST FOR ANY ENGINE

CHAMPION

SPARK PLUGS

CHAMPION SPARK PLUG COMPANY, TOLEDO 1, OHIO

Here's your "Task Force" for any type of fire

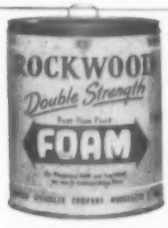
Complete team of Rockwood portable products combines speed, versatility and economy

Separately, each of these Rockwood products has its own particular advantages for fighting various types of fires. Together, they make a mobile, multi-purpose task force that delivers a whale of a lot of protection against *any* type of fire, whether it's Class A (wood, paper, rags, etc.), or Class B (flammable liquids). That includes personnel protection, too, because safety for the men who use them is an essential factor in all Rockwood fire fighting products.

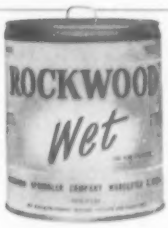
Rockwood's long, practical experience and constant research bring you not only new *efficiency* but new *economy* in fire-fighting methods and equipment. It will pay you to learn more about these and many other Rockwood products. Mail the coupon today for complete information on Rockwood's specialized fire-fighting products.

* **Type SG-60 Nozzle.** A true all-purpose nozzle that fights fire 5 ways. It discharges high velocity WaterFOG, low velocity WaterFOG (with applicator), FogFOAM, solid stream of water or solid stream of FOAM.

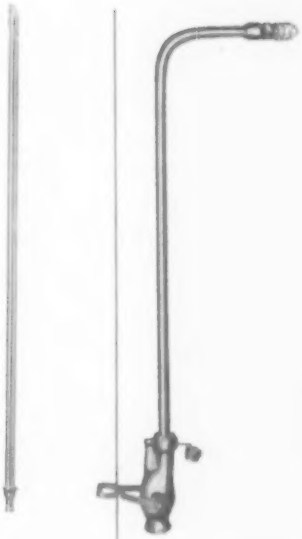
FOAM and "Wet" Eductor with the new FW Metering-Check Valve. Introduces Rockwood FOAM or "Wet" into hose lines, automatically proportioning correct amount of FOAM and "Wet" to water. Also usable wherever one liquid is fed into another on a fixed percentage basis.



* **Rockwood Double Strength FOAM.** Puts out fires in flammable liquids, and in ordinary combustibles, quicker, at lower cost. Three parts FOAM and 97 parts water create a tremendous heat-resistant blanket. Flows freely at —15°F.

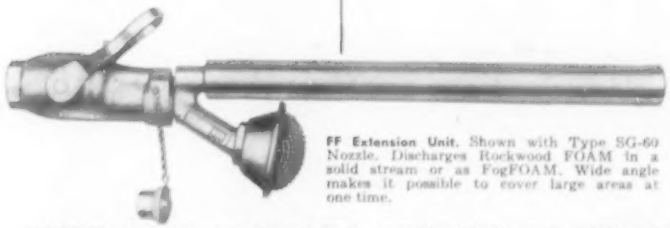


* **Rockwood WET.** One part WET mixed with 99 parts water increases water's penetration and extinguishing action. Gives quickest results against deep seated fires. Saves time, water, manpower.



Bayonet Piercing Applicator. Has a hardened steel cutting tool attached to tip, enabling operator to pierce through partitions, into interiors, etc. Discharges low velocity WaterFOG or FogFOAM.

* **Long Extension Applicator.** Discharges low velocity WaterFOG in an umbrella pattern, smothering fire without causing turbulence to flammables. Excellent personnel protection is another advantage.



FF Extension Unit. Shown with Type SG-60 Nozzle. Discharges Rockwood FOAM in a solid stream or as FogFOAM. Wide angle makes it possible to cover large areas at one time.

**NOTE: The products shown here have all been Tested and Listed by Underwriters' Laboratories, Inc.*

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"he's drilled over 60 miles so far...with just one set of U. S. Rainbow V-Belts,"

says "Red" Royal

"Red" is talking about "Catline" Dodson, a young contractor who has only one rig, so breakdowns to him are murder.

In the past 4½ years "Catline" Dodson (of Edmond, Okla.) has shifted his rig over 75 times, drilled a total of 320,000 feet so far—with the *same set* of U.S. Rainbow® V-Belts on a *compounded* mud pump drive. "It might take me up to 6 hours to replace a broken set of belts," he says, "and I figure my downtime at about $50 an hour. But U.S. Rainbow V-Belts have never failed me, not even in the near-zero temperatures. The set has so far drilled over twice the footage I'd estimated."

"Red" Royal knows many a toolpusher who will tell you Rainbow V-Belts are unbeatable for reliability. Each belt has the unique Equa-Tensil Cord Section that enables each cord to pull its full share of the load, for extra power. Your drilling dollars deliver *more* when you have "U.S." V-Belts, and other quality "U.S." oil-field products.

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Driller I. L. Dodson checking one set of U. S. Rainbow V-Belts.

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United States Rubber

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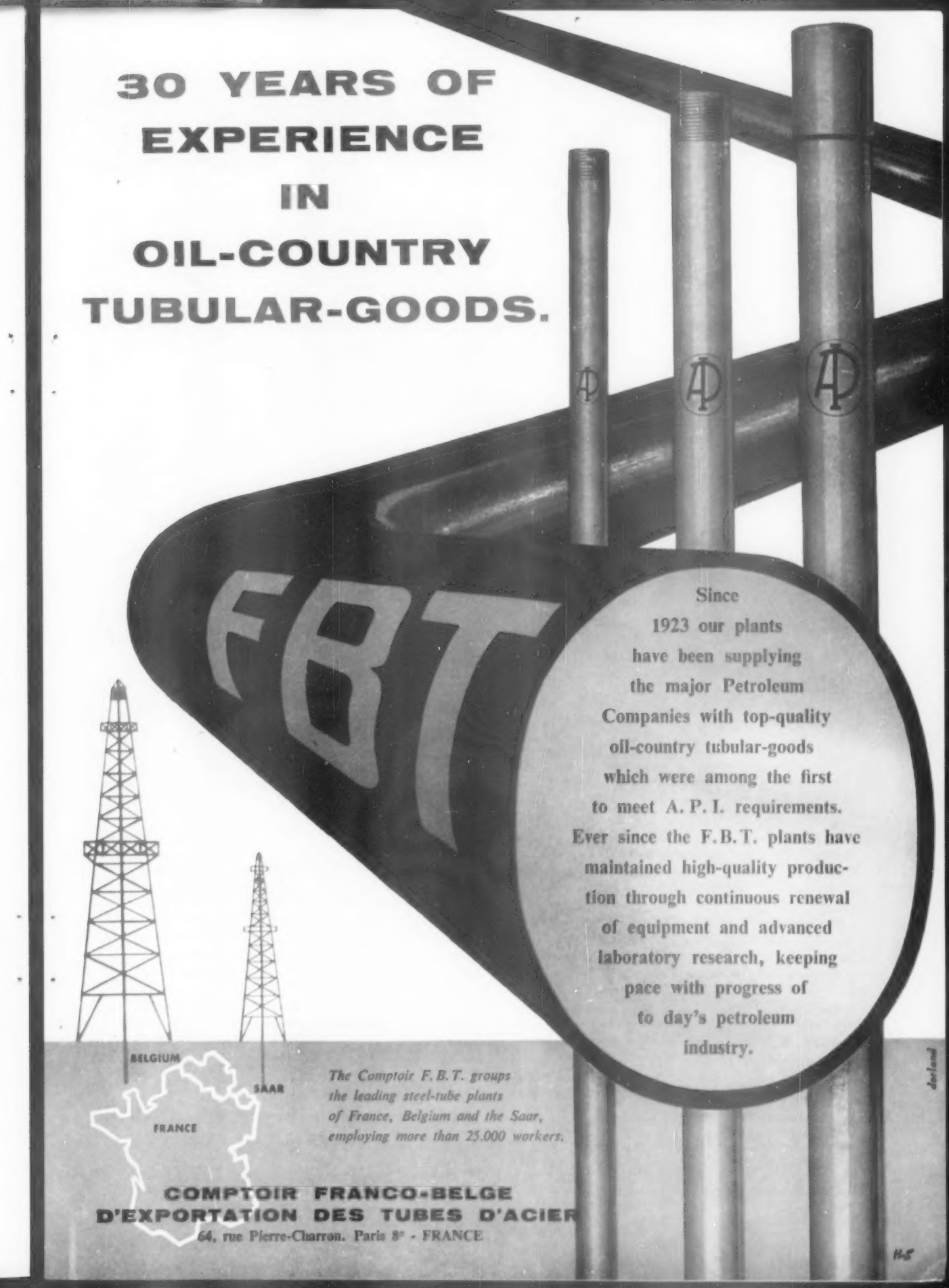

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We've done one thing for you. Chapman's Motor Units . . . for operation of valves, floorstands and sluice gates . . . are in the best of condition for accurate performance and longer, lower cost life.

We've made them as you like them . . . simplified them . . . streamlined them . . . taken off all the fat. In fact, when you look at a Chapman Motor Unit today, you can only find approximately *half as many parts* as on any other unit.

This simplicity, combined with Chapman's traditional ruggedness, means less trouble and lower maintenance over a longer period of smooth, accurate performance.

How can you go wrong? With Chapman Motor Units, the simplified design . . . the sturdy construction . . . mean no drift; less slash, accurate micrometer-controlled limit switch for predetermined seat tightness; quiet motor driven operation at all *times*. All at the lowest overall cost.

No trouble with operating positions. Operation is assured at any angle. Rugged stub-tooth gears need no grease or oil. No trouble with operating conditions. All units are weatherproof . . . *steam tight*. No trouble even with installations. When used with floorstands they are completely wired at the factory . . . ready to connect with your leads. Easy and simple to install.

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The Chapman Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

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About NAYLOR Performance

The familiar Naylor spiral brings the outstanding performance of this light-weight pipe right out into the open — for gas-gathering and field processing lines.

It's no secret that Naylor pipe gets its extra strength and safety from the exclusive lockseamed, spiralwelded structure. The spiral truss acts as a continuous expansion joint to absorb shockloads, stresses and strains. In addition, it provides greater collapse strength which permits operation under either vacuum or pressure. Moreover, the Naylor structure maintains its true cylindrical form and holds accurate diameter in transportation, handling and use.

Naylor pipe comes in diameters from 4" to 30", and is available with standard weight pipe ends for faster, stronger field welds.

Write for Bulletin No. 507 or call our distributors.

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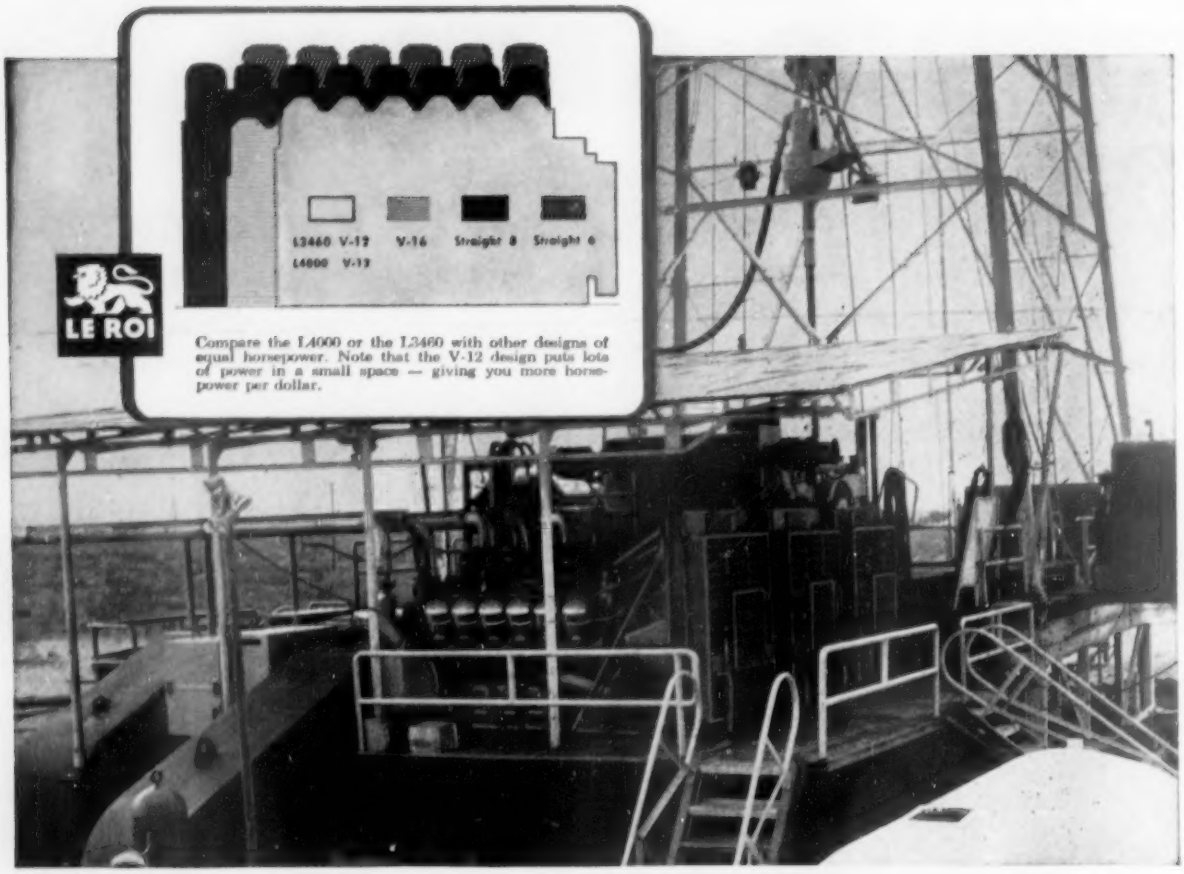

Compare the L4000 or the L3460 with other designs of equal horsepower. Note that the V-12 design puts lots of power in a small space — giving you more horsepower per dollar.

An engine doesn't have to be BIG to be POWERFUL!

The compact, V-12 design of Le Roi's L4000 and L3460 proves it!

Le Roi's L4000 and L3460 engines represent the first truly new design concept in 15 years. They are compact high-output engines, designed with short stroke to give you greater horsepower and speed without compromising engine life.

In addition to the advantages of short-stroke design, these modern V-12's have lightweight pistons, short-radius rotating parts — hydraulic tappets — crankshaft vibration dampener — sensitive controls. That's why they give you hair-trigger response to load demands.

The fuel economy of these engines is good, too. Thanks to advanced-design manifolding, low friction bearings, and low power loss to accessories, they give you rock-bottom fuel consumption.

Yes, big surprises come in small packages. That's especially true of the L4000 and L3460. These engines are conservatively rated to give you plenty of power in reserve. The L4000, for example, provides 655 max. hp. and the L3460, 600 max hp. And they have a wide speed range, too, up to 1350 rpm. That's why these engines are ideally suited to a great many oilfield applications: drilling, pipeline station, generator, gas booster, etc.

Engines may come bigger than these Le Roi's, but they sure don't come better! See for yourself — ask your supply house or Le Roi distributor to show you an L4000 or L3460 at work. Call him soon. Bulletins are also available — just write for them.

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 1, Wisconsin

PORTABLE AIR COMPRESSORS

TRACTAIR

STATIONARY AIR COMPRESSORS

AIR TOOLS

ENGINES

34" full opening high pressure gas line valve—biggest ever built

This Grove Seal-O-Ring Gate Valve with the rugged fabricated steel body design is actuated by a hydraulic piston operating on pressure from the line.

THE WHOLE VALVE IS RIGHT HERE

When valve is full open or closed, bubble-tight seals on both sides of the gate completely isolate line pressure in the conduit. The body, serving merely as framework for operating mechanism and to prevent loss of product while gate is in motion, may be drained or vented to atmosphere when gate is open or closed. Integrity of seals can be checked any time by a tell-tale valve on the body.

602

GROVE SEAL-"O"-RING Gate Valves

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wherever oil men gather...

you hear it more and more...

for my money...it's...

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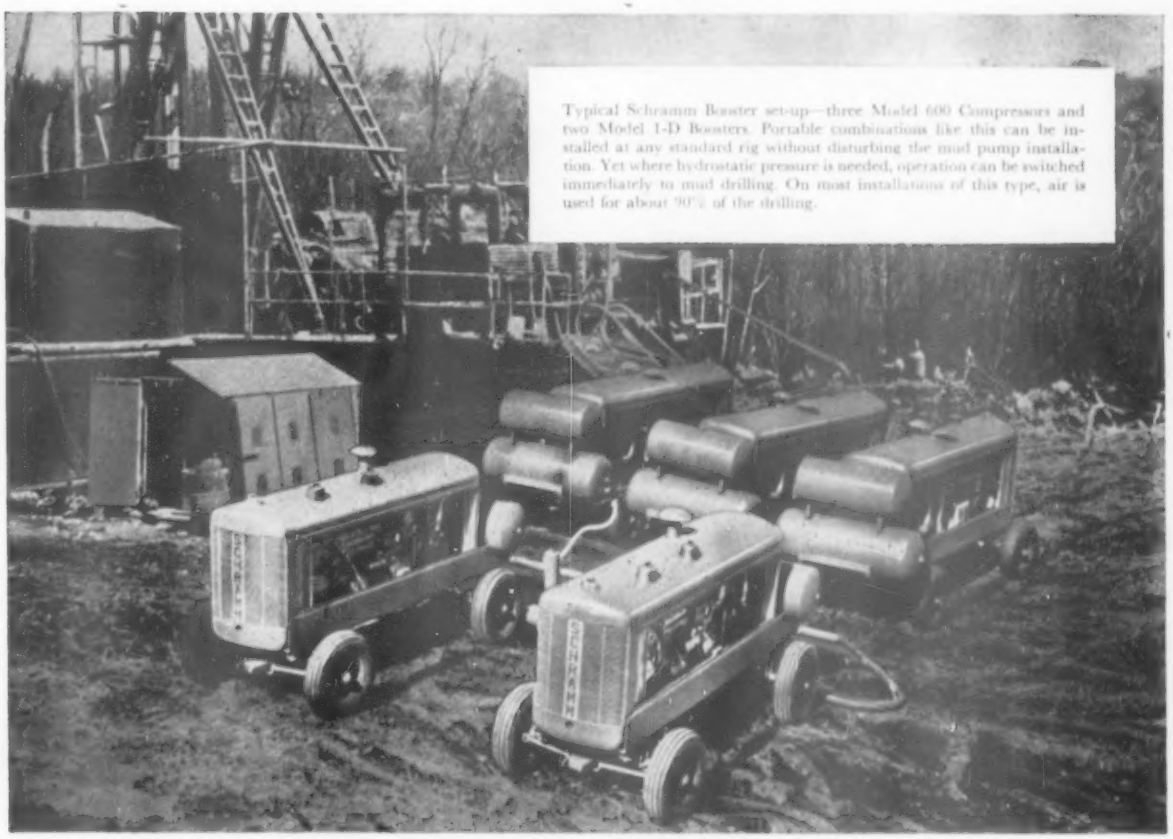

Typical Schramm Booster set-up—three Model 600 Compressors and two Model 1-D Boosters. Portable combinations like this can be installed at any standard rig without disturbing the mud pump installation. Yet where hydrostatic pressure is needed, operation can be switched immediately to mud drilling. On most installations of this type, air is used for about 90% of the drilling.

Portable booster system...flexible as you wish

Gives any volume of air up to 1800 cfm at pressures up to 1500 psi

When you need compressed air at higher than 125 psi—for drilling oil or gas wells, or testing pipe lines—get it at lowest cost with this flexible combination of Schramm Portable Compressors and Boosters. By varying the combination of units, you get desired volumes and pressures—from 125 cfm at 100 psi up to 1800 cfm at 1500 psi.

Each of the three Model 600 Schramm Compressors shown delivers up to 600 cfm at pressures up to 125 psi. If you need more pressure, use one or two of the boosters. Two compressors (at slow speed) and one booster deliver 900 cfm at up to 500 psi. And all three compressors (running at rated speed) and both boosters give up to 1800 cfm at up to 1500 psi. You get exactly what you need for the specific job.

Compressed air drilling of oil and gas wells becomes more practical than ever with this flexible, economical system of portable units. Schramm combinations increase penetration rates by 40% to 237% over conventional rigs. Holes are cleaner and straighter. Mud cake is eliminated. Bits last up to 348% longer. Cuttings can be examined continuously. Core recovery is excellent. Cement requirements are lower. And the use of air, instead of mud, eliminates cost of water and chemical mud. Also, you have no lost-circulation problems when you drill with air.

If you have never used the Schramm method of drilling with air, your drilling costs may be as much as 50% higher than they should be. Start cutting them now; get full information on Schramm Portable Compressor-and-Booster Combinations. Free data sheet shows nine combinations available. Send for your copy and ask for full details of rotary rock drilling with Schramm Portable Compressors and Boosters. No obligation.

Schramm Portable Compressors and Boosters are easy to install. Simply wheel them into position, connect to manifold and begin drilling without further adjustment. All Schramm Boosters and Model 600 Compressors are powered by the same engine, either the International Harvester UD-1091 diesel or UT-1091 gas engine. Result: fewer service parts, lowest maintenance.

Your local Schramm Dealer is listed in the Yellow Pages of your telephone directory.

Schramm, Inc.

MANUFACTURERS OF AIR COMPRESSORS

630 North Garfield Ave. West Chester, Pa.

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PRESSURES TO 500 P.S.I.

E-4 DRILLING MACHINE

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Boring bar travel 9⅞"
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"O" ring boring bar seal

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EH-1 DRILLING MACHINE

Drills ¼" through 1"
Boring bar travel 9⅞"
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They Say—

Unit Approach Wins Friends

Dear Sir:

The acceptance of the model form operating agreement appears now to be even more general than any of the committeemen would have presumed. I personally feel that the committee's work is less responsible for this than is the fine cooperation of the Journal ("The Unit Approach," The Oil and Gas Journal, June 18, page 343) coupled with that of the Ross-Martin Printing Co.

The agreement has been provided several thousand addressees, and I am informed that it is now beginning to be in quite wide usage. We are sincerely grateful to you for the very splendid work you have done concerning this project.

John H. Folks
Chairman Model Forms
Operating Agreement Committee
Oklahoma City.

(Editors note: The Model Forms Operating Agreement Committee is a voluntary group encouraged by a number of oil companies. The form mentioned by the Journal was the result of 3 years study by the group.)

I.P.A.A. Claims Law Ignored

"On June 26, Office of Defense Mobilization Director Arthur Flemming announced that the cabinet committee had concluded that planned crude-oil imports for the third quarter should be reduced to a level 4 per cent below actual imports for the first 6 months of the year . . . The record shows a serious failure by importing companies to comply with the Government request . . . There has been a 35 per cent compliance, leaving these planned imports at . . . 18 per cent above the first 6 months instead of 4 per cent below the first 6 months.

"Some conclusions based on the accomplishments under the present law are in order.

"Importing companies either cannot or will not comply with the efforts to obtain voluntary compliance under the present law.

"Importing companies continue their excessive imports in defiance of requests from the Office of Defense Mobilization . . .

"Imports continue to increase under a law designed to restrict them.

"The law requires that imports be held to the 1954 relationship. No action has yet been taken by governmental

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how to
CUT CORROSION LOSSES
a report by Koppers Company, Inc.

C. U. Pittman
Supervisor Technical Service

Ideally, effective corrosion control should start in the design stage of a new building or unit. The design engineer—by avoiding sharp edges, grooves, thin supporting members, etc.—can eliminate many of the common starting points for corrosion.

But in any case, the first step in preventing corrosion is *adequate preparation of the surface* before applying the protective coating. A really good—and economical—protective coating should *prevent* corrosion, not just cover corrosion products.

* * *

Most authorities agree that there are two chief objectives in good surface preparation: removing contaminating materials and producing a surface that will promote a good mechanical bond with the coating. The life and effectiveness of the coating system depends upon the degree to which you attain either of these objectives.

Actually, a tightly adherent surface of mill scale would make an ideal protective coating in itself—*if* temperatures remained constant. But since the scale and the virgin metal have different co-efficients of expansion, temperature changes and mechanical flexing cause flaking of the mill scale even under coatings. (Note: In over-the-ditch coating, it is not practical to remove all mill scale—buried pipe is not so subject to temperature change.) Another problem with mill scale is that electrochemical action between the mill scale and the metal accelerates corrosion and causes pitting.

Rust provides a certain amount of protection by slowing corrosion. But since it is non-adherent and porous, corrosion continues.

To perform an effective, long-life job, any coating must have a proper surface to which it can adhere. As revealed by photomicrographs, a slight roughness produces the best mechanical bond by increasing surface area and providing a tooth for the coating. Chemical bonding depends on the inherent molecular structure of the coating material. Some coatings must depend on a mechanical bond only. But coal tar coatings, having polar groups, will bond chemically as well as mechanically.

* * *

The important point on which most corrosion engineers agree—and which our applications research has proved—is that surface preparation is an integral part of the coating specification. By paying as careful attention to surface preparation methods as to selecting the right coatings, you will assure trouble-free, economical corrosion control.

* * *

We will report to you soon on the various surface preparation methods. In the meantime, we'd like to hear about your corrosion problems. Write: Koppers Company, Inc., 1301 Koppers Building, Dept. 104J, Pittsburgh 19, Pa. District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh and Woodward, Ala. In Canada: Koppers Products, Ltd., Toronto, Ontario and Edmonton, Alberta.

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agents to whom Congress delegated authority to accomplish this. Therefore, it is impossible to judge the effectiveness of the law. Voluntary compliance with the objectives of the law has not restricted imports to the level required.

"Imports should now be restricted by the Government as directed by the law. That is the action sought in the formal petition filed August 7 by 19 oil and gas associations, including I.P.A.A."

Russell B. Brown, general counsel for the Independent Petroleum Association of America, in a bulletin to I.P.A.A. members.

Natural-Gas Supply Abundant

"The American Society of Petroleum Geologists estimates that in the nation there are about 1,800,000 sq. miles of territory with sedimentary formations favorable to oil and gas production. To date only about 200,000 sq. miles of that area has been explored for oil and gas.

"For a number of years the amount of proved natural-gas reserves in existence has been about 22 times that of the annual production, despite ever increasing production. There is little doubt among those who are expert in the matter of gas supply that our industry can continue to expand without danger of running out of gas."

George S. Young, president, the Columbia Gas System, in a report to employes.

Proposition 4 and Monopoly

"Working together voluntarily under the sanction of existing laws, California operators lead the nation in unit production . . . For this record of successful, voluntary cooperation, the proposed act would substitute compulsion and control. It would make mandatory unitization of any field or pool where lessees and land owners representing 75 per cent of the surface area would agree. This democratic-sounding proposal is a misleading fraud. Here's why.

"There are 73 recognized fields in California. In 52 of these fields, four companies or less have that ¾ interest. In the majority of the important fields, a combination of a few of the major companies would constitute the necessary 75 per cent. The minority—even though it may include more than 50 per cent of the operators—would be bound by that agreement forced upon them by the major interests.

"We maintain that unless a unit plan can be sold to the operators on its own merits something is wrong with it. To force an operator into such a unit

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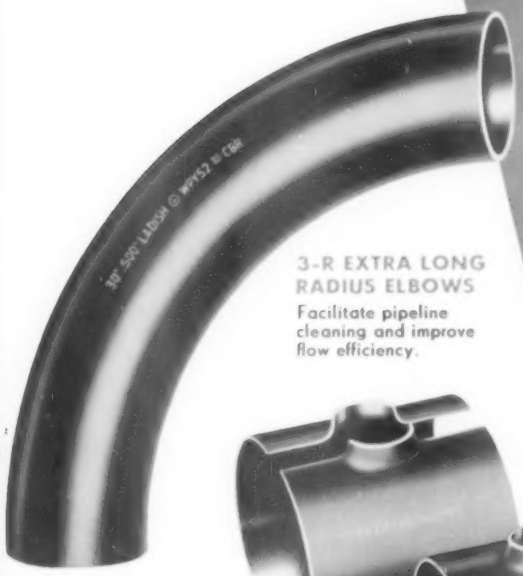

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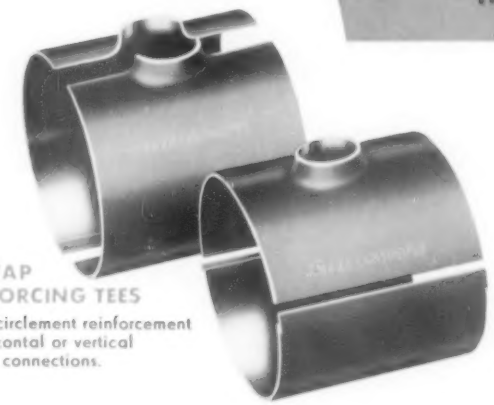

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BULLETIN 55-1

21-page bulletin presents descriptive data on Ladish pipe line fittings developments.

BULLETIN 55-2

82-page volume tabulates and graphically charts design pressures for steel pipe for gas transmission and distribution systems in accordance with recently revised Section 8 of ASA. B-31.1.8.

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against his will is nothing but confiscation of property.

". . . The proposed law sets up a commission of three men appointed by the governor with discretionary authority in almost all things pertaining to drilling, producing and well spacing . . . Its power is limited almost entirely by an ambiguous provision for preventing 'waste.' And 'waste' is defined in terms so undefinitive that no two competent engineers, let alone operators, could agree on their application.

"In the guise of a conservation measure, the bill 'prohibits,' 'provides,' 'regulates,' 'requires,' 'prevents,' and 'establishes' just about everything that is done in the development and production of an oil field. All of these words have the connotation of force, of compulsion, of regulation. If this isn't control, then what is?"

On Tour, magazine of Union Oil Co. of California, August 1956.

CALENDAR OF EVENTS

SEPTEMBER

19-21 Southeastern Gas Association, Hotel Sir Walter, Raleigh, N. C.

20-21 National Association of Corrosion Engineers, sixth annual short course, Centenary College, Shreveport, La.

20-21 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo.

20-21 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division, annual membership meeting, Roosevelt Hotel, New Orleans.

20-22 Oklahoma City Geological Society, field conference, Guymon, Okla.

21 Southern Gas Association, conference of gas measurement superintendents, Tutwiler Hotel, Birmingham, Ala.

24-26 American Society of Mechanical Engineers, petroleum mechanical engineering conference, annual meeting, Statler-Hilton Hotel, Dallas.

26-28 Rocky Mountain Mineral conference American Institute of Mining, Metallurgical & Petroleum Engineers, New house Hotel, Salt Lake City.

28 Natural Gasoline Association of America, Oklahoma regional meeting, Skirvin Hotel, Oklahoma City.

OCTOBER

1-5 American Institute of Electrical Engineers, fall general meeting, Morrison Hotel, Chicago.

2-3 Texas Mid-Continent Oil and Gas Association, thirty-seventh annual meeting, Rice Hotel, Houston.

3-5 Standards Engineers Society, fifth annual meeting, Hotel Willard, Washington.

7-9 American Association of Oil Well Drilling Contractors, annual meeting, Texas Hotel, Fort Worth.

8-10 American Society of Mechanical Engineers, American Society of Lubricating Engineers, lubrication conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

9-10 Southwest Kansas Petroleum Industry and University of Kansas, fourth annual two-day gas measurement institute, Liberal, Kan.

10-12 International Geological Symposium of the Williston Basin, Bismarck, N. D.

11-12 California Natural Gasoline Association, fall meeting, Sheraton Huntington Hotel, Pasadena, Calif.

14-17 American Institute of Mining, Metallurgical & Petroleum Engineers, Petroleum Branch, fall meeting, Biltmore Hotel, Los Angeles.

14-20 OIL PROGRESS WEEK.

15-17 American Gas Association, annual meeting, Atlantic City, N. J.

18-19 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Rufus Garrett Hotel El Dorado, Ark.

18-21 Permian Basin Oil Show, Odessa, Tex.

22-24 National Lubricating Grease Institute, annual meeting, Edgewater Beach Hotel, Chicago.

22-24 Rocky Mountain Oil and Gas Association, annual convention, Cosmopolitan Hotel, Denver.

23-26 National Association of Corrosion Engineers, south central region, San Antonio.

24-26 Tracerlab Symposium on Applications of Radioactivity, Hotel Statler, Boston.

25-26 American Society of Mechanical Engineers, American Institute of Mining, Metallurgical & Petroleum Engineers, nineteenth annual meeting, Sheraton Park Hotel, Washington.

26 Natural Gasoline Association of America, southern regional meeting, Captain Shreve and Washington-Youree Hotels, Shreveport.

26 American Institute of Chemical Engineers, South Texas Section, elev-

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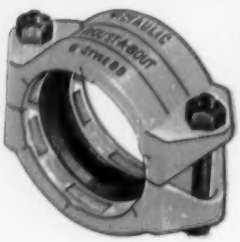

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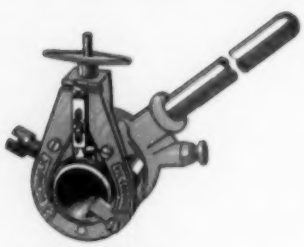

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enth annual technical meeting, Galvez Hotel, Galveston, Tex.

29-30 Illinois Geological Survey, Petroleum Engineering Conference on Waterflooding, University of Illinois, Urbana, Ill.

29-30 Independent Petroleum Association of America, twenty-seventh annual meeting, Statler-Hilton Hotel, Dallas.

29-31 Energy Resources Conference, sponsored by the Denver Chamber of Commerce, Denver.

29-Nov. 1 Society of Exploration Geophysicists, annual meeting, Roosevelt Hotel, New Orleans.

31-Nov. 2 Gulf Coast Association of Geological Societies, sixth annual convention, Plaza Hotel, San Antonio.

NOVEMBER

1-2 Louisiana Polytechnic Institute, fifth annual instrumentation conference, Ruston, La.

7-8 Instrument Society of America, Philadelphia Section, symposium on process data logging, Stratford Hotel, Philadelphia.

8-9 American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists, Pacific Coast Joint Regional Meeting, Ambassador Hotel, Los Angeles.

8-9 Society of Automotive Engineers, Inc., national fuel and lubricants meeting, Mayo Hotel, Tulsa.

12-15 American Petroleum Institute, thirty-sixth annual meeting, Conrad Hilton Hotel and Palmer House, Chicago.

19-20 American Institute of Mining, Metallurgical & Petroleum Engineers, North Texas Secondary Recovery Symposium, Municipal Auditorium, Wichita Falls.

25-27 Kansas Independent Oil and Gas Association, nineteenth annual meeting, Broadview Hotel, Wichita.

25-30 American Society of Mechanical Engineers, Statler Hotel, New York.

30 Natural Gasoline Association of America, Panhandle-Plains regional meeting, Herring Hotel, Amarillo, Tex.

DECEMBER

3-4 New Mexico Oil and Gas Association, annual meeting, Alvarado Hotel, Albuquerque.

9-12 American Institute of Chemical Engineers, annual meeting, Statler Hotel, Boston.

1957

JANUARY

14-16 Pipe Line Contractors Association, ninth annual convention, Boca Raton Hotel and Club, Boca Raton, Fla.

14-18 Society of Automotive Engineers, annual meeting, Sheraton-Cadillac and Statler hotels, Detroit.

21-25 American Institute of Electrical Engineers, 1957 winter general meeting, Hotel Statler, New York City.

FEBRUARY

22 Natural Gasoline Association of America, Permian basin regional meeting, Scharbauer Hotel, Midland, Tex.

24-28 American Institute of Mining, Metallurgical and Petroleum Engineers, annual meeting, Hotels Roosevelt and Jung, New Orleans.

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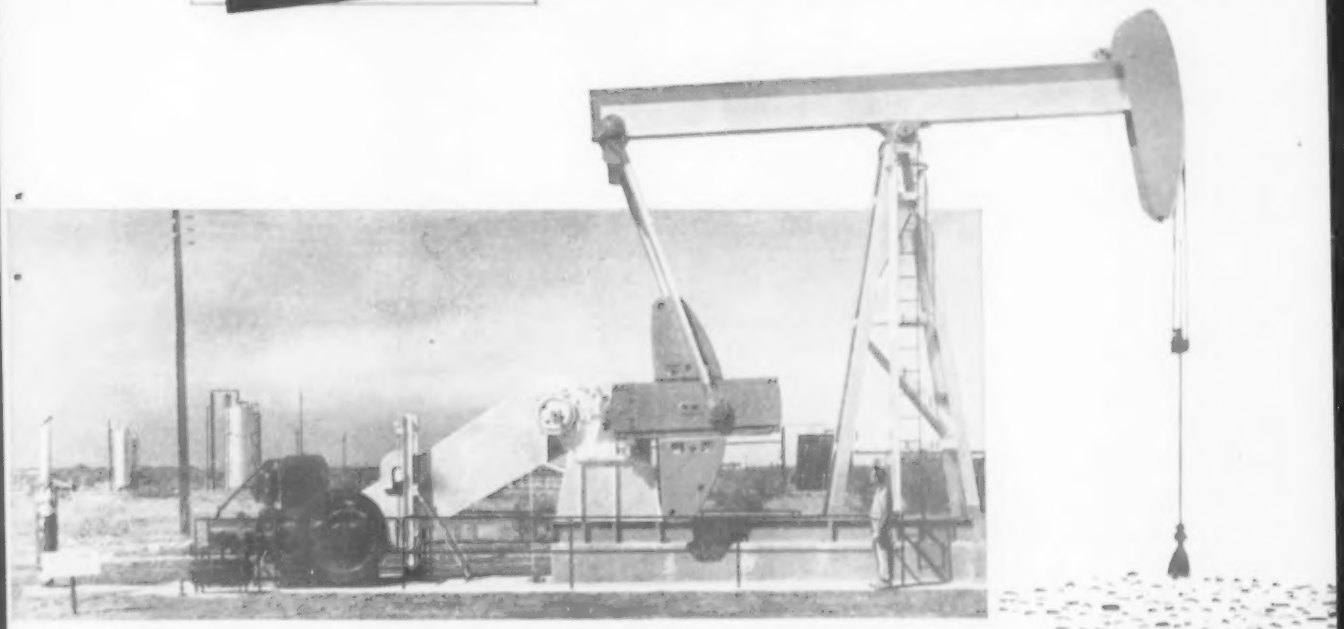

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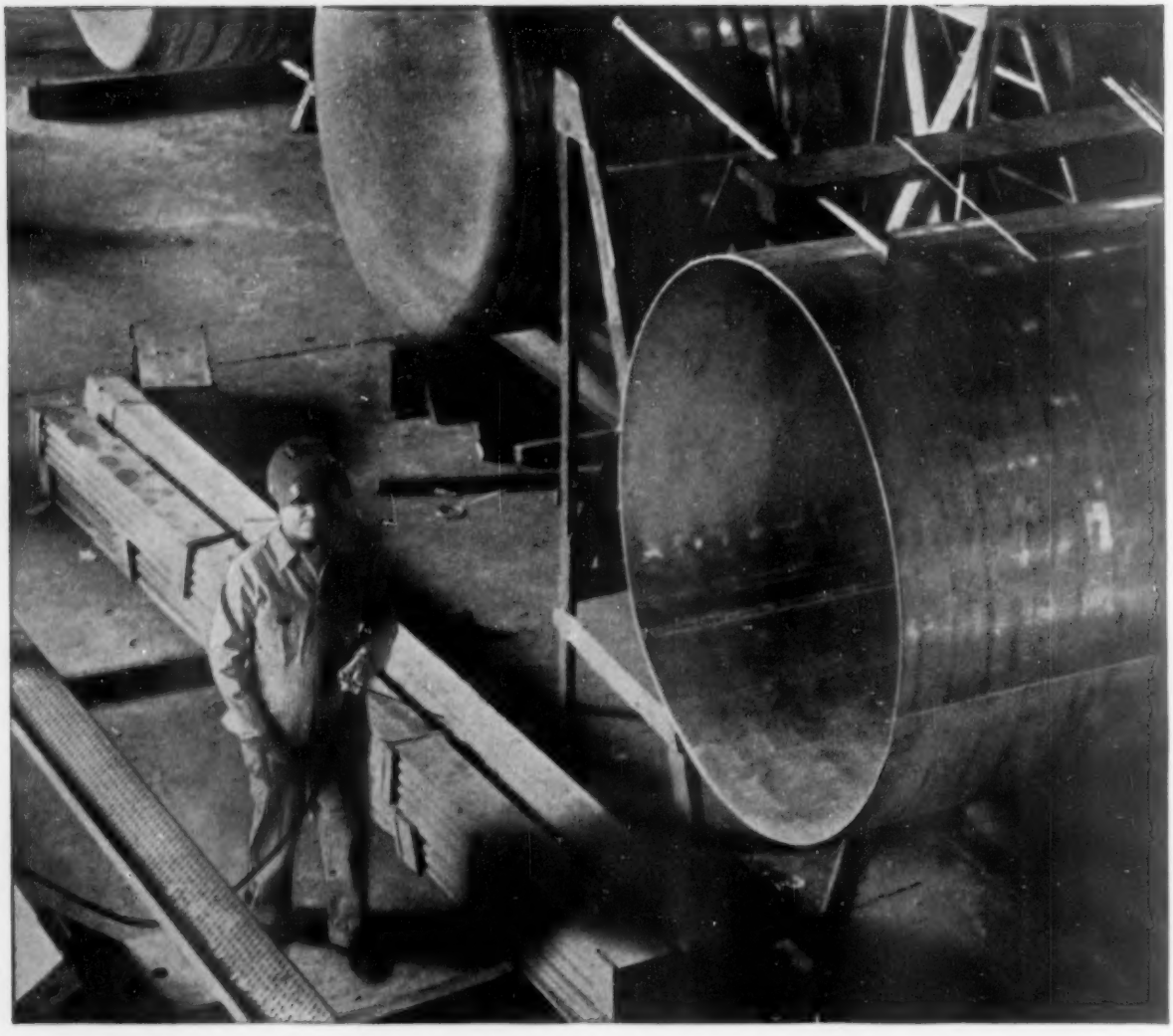

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JOURNALLY SPEAKING . . .

All in a Day's Work

THIS isn't a necktie party, in spite of the grave countenance on the central figure.

The man on the rope is merely contemplating the horrible possibilities of a slip of the grip.

He's R. B. Ward, the Journal's photographer. This unusual scene is just part of the preliminaries before R. B. shoots some pictures of offshore drilling operations for Journal readers.

The rope represents Loffland Brothers' idea of the simplest way of getting people from Shell Oil Co.'s crew boat to the platform where Loffland is drilling.

Out in the gulf when the waves are high, it's next to impossible to park the boat at the platform and step across. The boat lurches back and forth and up and down, and it's apt to drop 6 ft. just as you step. Any sailor who's had to board ship from a landing craft after a drunk liberty ashore knows the problem.

So Loffland had the idea that if you drop the rope into the boat, a visitor grabs it and hangs on, it's an easy matter to hoist him up and swing him aboard the platform.

Mostly, though, drilling crewmen are younger and tougher than our R. B. And it looks here as if he were more concerned than the average over what would happen if he slipped into the water below and another wave smashed the crew boat against the platform at the same time.

But there's no breed alive with more brass than photographers, and very little fazes them. They'll interrupt a panel discussion to get a shot of the chairman, climb a rig for a different angle, or mount a banquet table to get a clear view of the principal speaker. And one I knew nursed a coral snake back to consciousness so that he could get a movie shot—in color—of the varmint striking at him.

R. B. is true to the breed. Every job is different. But photographic jobs always have been. So, R. B. figures, an unusual aspect on any one tour is to be expected. Hanging from a rope over the choppy gulf is all in the day's work.

No Charm Here

THE old saying that the third time is a you-know-what . . . well, it isn't so.

Some weeks ago we carried an item that the Universe Leader, the world's largest tanker, had been launched in Japan. Its size: 84,730 tons. Only it came out in the book 83,900 tons. A week later another item mentioned the big ship, this time the figure came out 94,730 tons. Obviously a typo.

We got letters asking which figure was correct. Shamefacedly we had to say neither was right. Then we invited disaster by promising that if ever again we printed the figure it would be absolutely correct.

Last week we got another letter—a photostat of the one we had sent, with the promise marked in red. Down at the bottom was a note: "See issue of Sept. 3, page 75!!!" Sure enough: 84,700 tons. Lightning had struck again—in the same spot.

The next guy who misses that figure will have to write "eighty-four thousand, seven hundred thirty tons" (spelled out, too) 500 times and maybe more.

—*Ted Armstrong.*

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Oil's substitutes faced with tough competition

IN a fast-moving technical and imaginative age no existing operations in today's economy are inviolable to those who would replace present practices and products with something new.

The oil business and the closely related automotive industry are no exceptions to this challenge of the substitute.

There are those who envision synthetic products made from a variety of materials which would replace gasolines refined from crude oil. Others would supplant the reciprocal engine with new sources of power and new fuels.

There can be no criticism of this desire to improve methods and products. From such urges has stemmed the amazing industrial progress of this century.

But those who would move in on the existing oil industry and its principal customers would do well to have more than superficial knowledge of what they are trying to do.

LET'S LOOK AT SOME FACTS. This country's oil industry is approaching 60,000 new wells yearly, 36 per cent of which are dry. It gathers over 7 million barrels of crude oil from more than 525,000 wells.

This crude is delivered by thousands of miles of pipelines and by tankers to more than 300 widely scattered refineries in which billions have been invested in complicated processing facilities.

And when all these operations are complete the principal product—automotive motor fuels—is made available at the refinery gate at a delivered price of 2 cents or less per pound. The other major products from the barrel of crude are still lower in price.

The oil business has no challenger among other large industrial operations in the cheapness of its finished products, regardless of the tests applied.

Some claims for gasoline substitutes are based on wholesale and retail prices. They ignore the federal and state excise taxes and costly marketing services which take more of the gasoline dollar than does the refinery price. Any substitute must compete with gasoline on a basis of refinery price.

MUCH HAS BEEN SAID about the inefficiency of the present types of internal-combustion engines which require gasolines as fuels. But here again the substitute has to travel a rough road competing with an engine which has become practically foolproof in operation.

Furthermore it should be kept in mind that the higher compression ratios and the higher octane ratings in motor fuels can be translated into more miles per gallon when and if users are willing to give up some phases of car performance in favor of economy.

Thus it is clear that the position of the automotive engine and its fuels was never less vulnerable as regards substitutes than right now.

This being true our final thought is that the oil industry, starting with the finding and production of crude oil, should be given every encouragement by its customers and by governmental units, to solidify and expand its present strong position.

Tandemed Clevelands set the pace on tough 78-mile line in North Carolina

PUSHING A 78-MILE NATURAL GAS LINE from Chapel Hill to Sanford, North Carolina, J. A. Jones Construction Co. of Charlotte used two Clevelands in tandem to set the pace on a tough construction job. The lead trencher, a Cleveland 95, opened up an initial cut to a depth of 2 feet. The second machine, a Cleveland 110, then dug the trench down to finished grade, an average of 3½ feet deep. Each cut was 18 inches wide.

Boulders, rock outcroppings and closely spaced culverts cut across the trench line every few feet. Rock blasting was required frequently with each shot covered by a heavy dragline mat. Three rock drilling crews were kept busy most of the time. In spite of the difficulties encountered, the job moved forward at the rate of a mile a day or better—trench dug, pipe joined and laid, and backfilling completed.

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Current and significant in . . .

The Industry This Week

Industry

• **Hopes are rising for industry cooperation** on a new gas bill early next year. Producers, distributors, and pipeliners reportedly are approaching agreement on the basis for a bill to replace defeated Harris-Fulbright measure. P. 122.

Suez crisis deepens. British shippers have stopped chartering vessels for the run. Underwriters have skyrocketed insurance rates. Threats to canal shipping have U. S. poised to pull switch on emergency plans to supply oil to Western Europe. P. 121.

Natural Gas

• **Thousands of royalty owners** of gas production may face federal regulation, too, as result of latest FPC decision. P. 131.

Defiant Texas independents are blasting FPC indecision for keeping one of nation's biggest uncommitted natural-gas reserves in Wise County shut in for lack of market. P. 132.

Pipelining

• **Texas-Florida gas pipeline proposal** looks better. Deals have been completed to assure sources of supply and markets. P. 123.

Record prices of up to 17 cents an M.c.f. are being offered by pipelines to get new gas reserves developed recently in Oklahoma Panhandle. P. 120.

First scatter-microwave system in oil industry is being pioneered by Shell in Venezuela. It will give communications link between La Concepcion production and Punta Cardon refinery. P.138.

Production

• **Caution is the watchword** as operators slow down the drilling tempo in booming Bisti field of the San Juan basin. Painful memory of Spraberry is causing the ease up in development. P. 124.

Rubber tanks to replace steel tanks for storing fracturing fluids are helping Dowell cut costs of its well-stimulation processes in San Juan. P. 128.

Magnolia's new surfactant drilling mud is being made available to the industry through licensing. Its greatest possible use appears in deep drilling where down-hole heat is intense. P. 134.

Exploration

• **Three wildcats are evaluating the major oil strike in Kuwait,** the tiny Persian Gulf shaikdom which already leads the world in known reserves. The 1 Raudhatain discovery reportedly found pay sands 1,500 ft. thick, but it's still a tight hole. P. 137.

The bonanza of almost $400 million reaped by President Perez Jimenez off Lake Maracaibo concessions may mean a delay in any new sales in Venezuela. But companies hope for an early offering on Barinas tracts. P. 135.

Refining

• **Look for refiners to be producing** more jet fuel than avgas within a year. Use of jet airlines is changing the picture fast but the demand for both type aviation fuels is heading to new peaks. P. 116. Varieties of jet fuels and their cost of manufacture are pressing refinery problems. P. 119.

Du Pont survey shows road octanes average 95.7 for premium and 88.1 for regular gasoline. Tests in 11 selected cities show the road rating—the real test of gasoline performance—to be about 1 number below research on both grades. P. 129.

"Jet Age" Holds Big Things for Refiners

● The jet-fuel market will get a new look next year as commercial airlines enter the picture in a big way. This new look is arriving earlier than many expected. It will see jet-fuel production overtake avgas output—and the demand for both outstrip many early estimates.

● What refiners want to know about this new market is: How big will it be? What fuel will be used? What about fancy specs? What processing costs are involved?

George Weber
Refining Editor

NEW YORK.—Within a year U. S. refiners will be producing more jet fuel than avgas.

As the "Jet Age" in aviation officially arrives, demand for jet fuel will take another sharp upward swing and avgas demand will level off *(see chart)*. Actually, the demand for both fuels will outstrip early estimates of many economists.

Impetus is coming from the airlines, a minor factor up to now. But a lot of those purchase orders in the hands of jet aircraft manufacturers are beginning to turn into shiny new planes with whopping big appetites.

These and other firm orders for jet passenger transports permit a fair projection of fuel needs from now to 1960. But the picture is still cloudy.

Yet to be decided is whether the jets will burn kerosine or JP-4. Most of the talk centers around the former, but a national emergency could change that in a hurry. There wouldn't be enough kerosine to go around.

Also still getting a thorough airing are specifications. The airlines are now at the stage of talking refinements on existing specs. Sometime in the near future they will have to reach a decision, probably a compromise, on what they want and what they will pay.

The refining industry is watching these developments closely, but so far it's doing it from the sidelines. It is cooperating fully with airlines and manufacturers in providing data on availability and, to some extent, price. But the next play must come from the aircraft industry.

Refiners stand ready to serve the market whichever way it moves. Availability appears to be no problem and they can make fuel to any specification the customer wants — but at a price. And price looms important.

Airlines officials are going to be extremely sensitive about how much they pay. Two big reasons why are:

. . . **Tripled consumption.** The big jets taking off in 1958 will require roughly three times more fuel per passenger mile than existing piston-engine aircraft.

. . . **Doubling costs.** Aviation gas now represents about 22 per cent of an airline's operating expense. With jets, it will account for 35 to 42 per cent. And it could go even higher with too-rigid specifications. It would mean installation of expensive new processing equipment.

Demand: Bright

All estimates of future jet-fuel demand in this country indicate a rapid rise through 1960. But just how high it will go seems to have the experts guessing. Over the past year they have shown wide variations in projecting volume requirements up to that date.

These differences arise primarily from the headlong pace of jet aircraft development. New plane orders have been going out thick and fast.

At this time a consensus in this country shows another steep slope charted for demand from 1956 to 1960. The rapid conversion to military jets, which resulted in the demand rise of the past 4 years, will be repeated, at least to 1960.

Beyond that, estimates on total jet-fuel requirements are largely educated guesses. The projections on the accompanying fuel-demand graph are tentative and probably indicate the minimum to be expected from 1960 to 1965. Revision of the entire picture for that period is taken for granted.

Airlines: A Factor

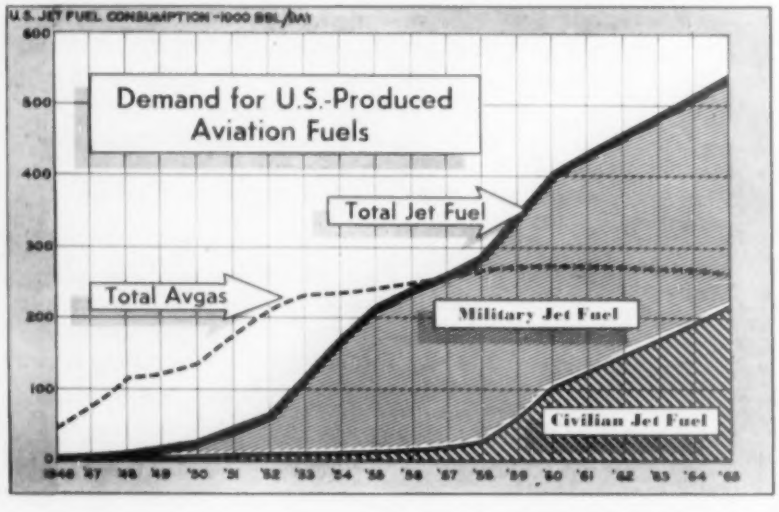
Firm orders have been placed for over 400 turboprop and turbojet planes for commercial use by U. S. flag airlines. Not all of these craft will be wholly fueled from U. S. stocks, but the needs of foreign lines refueling in the continental U. S. will probably more than offset this volume.

The latest tally on orders, not including options, looks like this:

	In Service	For delivery				
Type of plane	1955	'56	'57	'58	'59	'60
Boeing 707					42	11
Boeing Intercontinental					17	
Comet IV				4	10	
Convair 880					30	10
Douglas DC-8					19	70
Fokker Friendship			14	9		
Lockheed Electra				27	78	8
Vickers Viscount	17	38	20	12	5	

While these new craft represent a small part of the U. S. commercial fleet, their fuel needs will bring some important new business to refiners.

For example, a DC-7 in normal operation will use about 80 bbl. of avgas



NEW ERA in refining is being launched by planes such as the turboprop Vickers Viscount, left, and jet-propelled Boeing 707.

per calendar day. The new DC-8 will require an average of more than 400 bbl. of jet fuel during the same period.

Responsible sources estimate fuel requirements ranging from 33 bbl. a day for the two-engine Fokker, to about 430 bbl. a day for the big, long-range models.

Fuel demand . . . Assuming the new planes will fly an average of 3,000 hours a year, these fuel consumption estimates, when keyed to expected delivery dates, place airline requirements roughly at 3,000 bbl. a day for 1956, 9,500 bbl. a day for 1957, 10,300 for 1958, 45,000 for 1959, and 90,000 for 1960.

This growing demand, superimposed on estimates of rising military needs—from 220,000 bbl. daily next year to 300,000 bbl. daily by 1960—plus exports and test fuel for manufacturers, boosts the aggregate to over 400,000 bbl. daily by 1960.

Beyond that date, no projections are considered too valid today. Numerous airlines purchase options remain to be exercised and commercial plane deliveries beyond 1960 are still in doubt.

The soundness of jet operations for airlines, however, is now firmly established and the transition should continue without let up. U. S. financial circles are advancing vast sums of money toward this end.

Moreover, the airlines are taking a bullish view of business for the next several years. The consensus is that paid passenger miles will rise from 20 billion last year to 30 billion by 1960 and 35 to 37 billion by 1965. Some "blue sky" estimates call for 40 billion by 1960 and 80 billion by 1965.

For this expanding business, airlines will call on jets, which will handle an estimated 40 per cent of all mileage by 1965. But this does not mean the piston-engine craft will be replaced overnight. The boom in air travel is not waiting for the new planes.

THE DOUGLAS DC-8 is typical of the new fuel-hungry jets.

Avgas up, too . . . The latest thinking on avgas business extends the peak-demand period well beyond 1960. U. S. airlines have over 300 piston-engine aircraft on order—108 of them for delivery this year, 186 next year, and 39 in 1958. Most of these are long-range, four-engine models.

Efficient maintenance and replacement of parts will keep the present commercial fleet in operation for many years to come. While previous estimates saw the airlines merely cancelling out the loss in military avgas business, the experts now look for a slowly rising total in domestic avgas sales during the next years.

Jet Fuel: What Kind?

The refining industry is in the peculiar position of plotting a jet fuel course—and a bright one at that—without yet knowing just what fuel they will be making. The decision is up to the customer, and his position at the moment is fluid.

Best bet seems to be a lot of kerosine and a little JP-4. While most customers lean toward kerosine, there may be some who will still use JP-4 or an alternate fuel for some operations.

Availability a question . . . From the standpoint of availability, the wider-range JP-4, containing naphtha and kerosine fractions, has a considerable edge over kerosine. From 40 to 80 per cent of a barrel of crude can be turned into JP-4. For kerosine, the figure is only 6 to 8 per cent.

The octane race is making more low-octane gasoline fractions available for jet use. Also, military requirements for jet fuel are trending toward higher kerosine content. Some 25 per cent of this major market is expected to consist of this fraction by 1965.

It's easy to see how this would af-

A Look at Kerosine, JP-4 Specifications

	Kerosine type Proposed A.S.T.M	JP-4
Gravity, °A.P.I.	(*)	45-57
Freezing point, °F. max.	—40	—76
Aromatics, vol. per cent, max.	20	25
Aromatics over 400° F., b.p., per cent total, max.	5	
Olefins, vol. per cent. max.		5.0
Smoke point, mm., max.	20	(†)
Existent gum, mg./100 ml., max.	7	7
Accelerated gum, mg./100 ml., max.	14	14
Sulfur, total, wt. per cent, max.	0.25	0.4
Mercaptain sulfur, wt. per cent, max.	0.03	0.005
Heating value, net B.t.u./lb., min.	18,400	18,400
Flash point, °F., min.	Legal-150	
R.v.p., psi.		2-3
Viscosity, Cs at —30°F., max.	15	
Water tolerance	Pass	Pass
Corrosion, copper strip	1 (max.)	Pass
High-temperature stability	12 (max.)	
Distillation:		
10 per cent evap. at	347-400	
20 per cent. evap. at		290
50 per cent evap. at	450 max.	350
90 per cent evap. at		470
95 per cent evap. at	464 min.	
Final B.p., °F., max.	550	
Residue, vol. per cent, max.	1.5	1.5
Loss, vol. per cent, max.	1.5	1.5
Oxidation inhibitor added	Option	Option
Corrosion inhibitor added	Option	Yes
Metal deactivator added	Option	Option
Lamp burning test	Pass	

*Two proposals under consideration: (1) By agreement between operator and buyer. 39-41 A.P.I. and range of net heating value from 122,000 to 126,000 B.t.u./gal. †Reported only. Not limited.

fect the picture in the event of a national emergency. With the big tactical ships gulping it down by the carload, any fuel left to the airlines would almost certainly be something besides a straight kerosine blend.

Kerosine unrealistic? . . . Some suppliers think the airlines are being unrealistic in favoring kerosine. This viewpoint holds that when the chips are down and the bargaining begins, some customers may back off from certain arguments for kerosine.

Kerosine does have a higher B.t.u. content. Whether it will prove cheaper per B.t.u. is not yet established. Also, it is considered safer than JP-4, although both fuels are safer than avgas. Kerosine carries no federal tax—yet. But it is considered naive to expect this oversight to continue for long.

Two fuels . . . The probable outcome of all this bartering will be two fuels which will become standardized in the interests of lower handling costs. The airlines can then choose which they prefer—kerosine or JP-4.

While most of the jets now designed will operate on either, it looks like kerosine for the majority, with the wider-range fuel substituting in some low-temperature service.

The Specs: How Tight?

In order to avoid the higher costs of handling more than two types across the nation, individual requirements for modifications will probably give way to a common set of specifications for both JP-4 and kerosine.

Discussions are going on continuously. Representatives of airlines, aircraft manufacturers, and the oil industry will meet again with the American Society of Testing Materials this month to explore the possibilities of setting up specifications acceptable to all.

In order to retain guarantees on their new craft, the airlines must abide by the rules laid down by the builders. Hence, the views of numerous individuals and groups must be reconciled in the cold light of economics.

The refining industry will serve mainly in an advisory capacity. It will contribute to this meeting of minds by injecting vital availability and cost data into the discussions.

All-important safety considerations can be counted on to keep specs from becoming too lax. But economy will be the watchword. It is expected to keep specs on the liberal side, with a tightening-up to follow where necessary.

This will represent a different picture from the railroad diesel specs, which were originally more stringent than necessary and were later liberalized for economy reasons.

Heating value . . . The proposed A.S.T.M. specs on heating value now being reviewed (see specifications chart) represent some compromise with earlier specifications.

It is possible that the gravity range may be superceded by a B.t.u. basis since engine metering systems are based on heating value. Refiners can meet the B.t.u. range adequately.

Freezing point . . . There is still some disagreement on the freezing point.

For weight reasons, it is probably impractical to add heat to fuel in flight. The figure of —40° F. listed in the specifications chart is again a compromise, since some airlines have been talking about —50° to —60° F.

Pumpability . . . Actually, freezing point is considered a poor yardstick, since pumpability is the main factor involved. The A.S.T.M. has been asked to investigate and possibly develop a test for pumpability. It might replace the freezing-point specs some day.

Most users consider the —40° F. limit adequate. While temperatures considerably below that point are encountered, airlines have found that fuel cools off slowly. In one flight at air temperatures of —60° F., the fuel temperature dropped only 25° in 3 hours. Moreover, fuel will warm up at a faster rate than it cools.

Heat, generated by air friction of the new high-speed planes, also offsets some pumpability problems. At Mach 8, fuel will rise 40° to 45° over outside air temperature.

The customer does not yet know what pumpability or freezing point he wants, but —40° F. is considered on the safe side. Refiners can meet this requirement easily.

The proposed limit for aromatics over 400° F. will be dropped, since it is not realistic for kerosine. No correlations have been made on commercial craft between smoke point and actual smoking in flight. But there is no strong objection to the 20-mm. limit. Further studies may clarify this point and improve the limit from the refiner's standpoint.

Thermal stability . . . High-temperature stability has become an important specification for fuels used by supersonic military craft. It was originally felt that this would not become a factor in commercial fuels, but now it appears that it will. The commercial limit will not be as stringent as that required by military planes.

Most commercial craft still use outside air to cool their oil. Some of the larger models, however, may be using oil-fuel exchangers. Regardless of this, the fuel is exposed to relatively high temperatures from other sources and a moderate stability specification is expected.

This becomes a critical factor during idling. It can also be critical in the

secondary fuel system, which is brought into use during take off. When cruising speed is reached, the fuel remaining in the secondary system is exposed to radiant heat from the burners.

The Erdco coker, used to measure thermal stability, is considered sound enough when used in the "go no-go" test. It correctly indicates when a fuel will break down and plug burners in flight.

Independents' Status

Since thermal stability requires a low content of sulfur, high-boiling aromatics, olefins, and trace materials, this requirement could rule out some refiners.

Further processing with hydrogen or acid, or use of additives or both, will solve any thermal-stability problem known today. But this means added investment for some and may narrow the field.

In at least one refiner's opinion, however, thermal-stability requirements can be met, without expensive new equipment, by applying good housekeeping methods and better techniques.

Tentative rquirements for kerosine will certainly rule out the use of cracked fractions, but whether this will deny the market to some small refiners remains to be seen.

The independents no doubt won't be able to capture as large a slice of the commercial jet-fuel prize if the narrower-specification kerosine wins out. But standardization—almost sure to come—will rule in their favor.

Since few major oil companies maintain marketing systems broad enough to supply the airlines over their extensive routes, many smaller refiners should stand in a competitive position in their own restricted areas.

How broad the market . . . The entire refining industry is participating in the current JP-4 market.

A recent award for 30,000,000 bbl. of this fuel, costing $120,000,000, was shared by 53 companies operating 133 refineries in 31 states. Twelve of the nation's major oil companies, maintaining nearly 70 per cent of refining capacity, got about 64 per cent of the business.

It is premature to suggest what prices the new commercial jet fuels will bring until their character is more clearly established. But prospective suppliers had best be prepared for hard-headed bargaining.

Whatever these fuels turn out to be, they are going to represent a big market. Jet fuel is going to account for a considerably larger outlet, both from the standpoint of volume and dollars, than avgas ever did.

Jet Fuel: A Real Omelet

Outlook scrambled, N.P.A. symposium tells refiners; they face problem of making many different types economically

ATLANTIC CITY.—Refiners might as well face it. They apparently will be called upon to make a number of different jet fuel types over the next several years.

That was the one common thread of talk here last week in a jet-fuel symposium sponsored by the National Petroleum Association as a part of its annual convention.

Refiners sounded a warning on this score, too. They advised jet-fuel users that the fewer the types and the less restrictive the specifications, the less these new aircraft fuels will cost.

As the symposium saw it, this is the future picture:

. . . Commercial airlines seem to be leaning toward kerosine. But they probably will settle for a choice between a modified fuel of kerosine and JP-4.

. . . Military planes will require seven different types ranging from wide-cut gasoline to narrow specialty cuts for ramjets. Unlike commercial buyers, the military will not be primarily cost conscious and will stick to fairly restrictive specifications on many future jet fuels.

The symposium underscored one point: The need for further integration of ideas on the part of refiners, airlines, military, and aircraft makers to arrive at an economic system for making and distributing jet fuels.

The cost factors . . . Restrictive specifications will cost airlines money.

Some of these costs were pointed out by H. R. Porter of Standard Oil Co. of California, G. D. Gould and M. L. Wolden of California Research Corp. They asserted the airlines must determine the best compromise between desirable features they want in a fuel and its cost. They cited extra costs of:

. . . Lowering sulfur content. Engine life varies inversely with sulfur content but hydrodesulfurizing a Kuwait kerosine raises the cost per gallon by 0.5 or 0.75 cent to reduce sulfur to 0.2 weight per cent. Reduction of 0.1 per cent runs the cost up a full cent per gallon.

. . . Reducing freezing point beyond the minus 40 level. This can be done only by careful selection of stocks, cutting availability and raising costs. Solvent dewaxing capacity is not generally available. The speakers advised until this process is further advanced that freezing-point restrictions be set with great care to avoid high costs.

Standard fuel possible . . . It is possible to serve all subsonic and supersonic aircraft with one gasoline-type and one kerosine-type fuel.

But H. A. Murray of California Texas Oil Co., Ltd., declared airlines would have to take a realistic, objective approach to jet-fuel supply problems to achieve it. On the other hand, he said, if the recent hit-and-miss approach toward unrealistic specifications continues, the oil industry will wind up making 10 or 12 different types.

Murray predicted these developments:

. . . JP-1 and JP-3 may be discontinued.

. . . Present JP-4 type may remain substantially unchanged.

. . . A modified Derd-2482 might become a standard world-wide kerosine type if U. S. tax laws were revised and the freezing point modified slightly.

JP-5, with a low-freeze point, is now in critical supply and proposed specifications should be reviewed carefully.

Military differs . . . The Air Force seems to have other ideas.

B. F. Wilkes of USAF research and development said the military may need as many as seven different jet-fuel grades, including JP-4, 5, and 6.

The military is looking at a 36°-48°-gravity kerosine for Mach 2 and 3 operations, and a very low volatility 32°-38°-gravity distillate for speeds over Mach 3.

Military observers also predicted they'll need an RP-? and RJ-? for rockets and ramjets. These probably will have narrow gravity ranges between 30 and 40 and distillation ranges of 300° to 600°.

Commercial pattern . . . From the standpoint of the commercial jet fuel, refiners had best remain in a position to move with strength toward either kerosine or JP-4, said James H. Carmichael, president of Capital Airlines.

Although Capital chose kerosine, the pattern is not yet set, Carmichael said. Whatever the fuel, Carmichael foresaw a domestic commercial demand for jet fuel of about 1,400,000,000 gal. in 1962. On top of that avgas will rise from its present 1 billion gallons per year to equal the jet-fuel use by 1962. Carmichael refused to predict past 1962.

In business sessions of the convention, all N.P.A. officers were reelected for second terms, and the 750 delegates heard talks on small business and labor costs.

New Gas Brings Premium

Pipelines offering up to 17 cents an M.c.f. in Oklahoma area where until recently going rate was 10 to 12 cents

TULSA.—Pipelines are offering record prices to get new gas reserves developed the past 2 years in Beaver and Harper counties of the Oklahoma Panhandle area.

Contracts have been made or are in the works for 700 billion cubic feet of natural gas in the Laverne district of Harper County. Offers range up to 17 cents per M.c.f., highest ever paid in this section of the country.

Colorado Interstate Gas Co. has signed up an estimated 210 billion cubic feet controlled by a group of producers including Sunray Mid-Continent Oil Co., Gulf Oil Corp., and Champlin Refining Co.

The contract is similar to the one under which Colorado Interstate bought up all the reserves in Mocane field, Beaver County, last March. The company will pay 15 cents per M.c.f. for 1,000-B.t.u. gas with a bonus for additional B.t.u. content. Producers have no processing rights except for ordinary field separation.

Warren Petroleum Corp. is expected to build a gasoline plant to strip the liquids from the raw gas before it enters the pipeline. Products could be moved to the D-X Sunray Oil Co. refinery in Tulsa through Warren's Okan pipeline which runs nearby.

These 15-cent contracts are part of Colorado Interstate's application for expansion of its facilities which will come before the Federal Power Commission next month.

Michigan-Wisconsin deal . . . A deal is reported pending between Michigan-Wisconsin Pipe Line Co. and producers which control an estimated 490 billion cubic feet of Laverne reserves.

This group includes Sinclair Oil & Gas Co., Cities Service Oil Co., and Sun Oil Co., which drilled the discovery well about a year ago.

Michigan-Wisconsin is offering 17 cents per M.c.f. for 1,000-B.t.u. gas. The bonus for additional B.t.u. value would be one-tenth of a cent per 10 B.t.u., up to 2 cents. This would add up to 19 cents for 1,200 B.t.u. gas. Prices would escalate 2½ cents every 5 years, making the price for 1,000 B.t.u. gas 19½ cents in 5 years. (This compares with a 5-year escalation of 1 cent in some existing contracts.) Processing rights would be reserved for producers.

Michigan-Wisconsin would build a 40-mile line from the Laverne district to a compressor station in Kansas on the company's main line to Michigan.

Panhandle Eastern Pipeline Co. and Northern Natural Gas Co. are reported to have made offers which appear to be not as acceptable as Michigan-Wisconsin's.

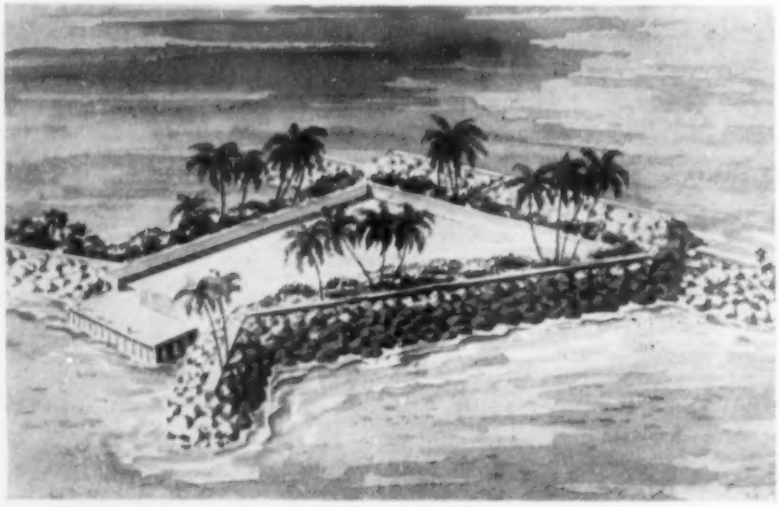
Producers are enjoying the competition for their reserves which happen to be located near several big-inch pipelines. "It's refreshing," one said, "to find someone wanting your gas for a change."

The contract with Colorado Interstate and the one pending with Michigan-Wisconsin will spur development in the fields, which are expected to be extended as more wells are drilled. The development has already spread across four townships and may extend westward across the Beaver County line. Development drilling is no problem with locations on 640-acre spacing.

Price comparison . . . If the FPC lets the 17-cent price go through, it would mean a spread of 7 cents between contracts in the Panhandle area.

Most old contracts for Hugoton gas are 10 to 12 cents per M.c.f. Until recently few were above this range and some old contracts started well below it. Recent deals have been for 14, 15, and 16 cents, the latter price paid by Natural Gas Pipeline Co. of America in the Camrick area.

The latest prices rival any in the big Southwest and Gulf Coast areas except for those paid in major offshore fields discovered recently. Pipelines have been reported willing to pay 20 cents per thousand cubic feet for reserves in this prolific new area which offers an assured supply for many years.



First of Two Drilling Isles to Go Up

VENTURA, Calif.—Richfield Oil Corp. will begin preliminary construction immediately on the first of two proposed drilling islands on the company's 1,175-acre state tidelands lease offshore from Rincon in Ventura County.

The three-acre island will be built about a half-mile offshore from Punta Gorda in about 45 ft. of water. It will consist of an outer ring of breakwater rock with a land filled center. Actual working area will be slightly more than one acre. A small craft dock will be built on the east side of the island for use by crew and supply boats.

Portable drilling masts will be used. As many as 70 wells can be drilled from the island. All production equipment will be concealed from the mainland by extensive landscaping. Guy F. Atkinson Co. of San Francisco will construct the island.

Richfield's original application to district engineers called for two islands on the lease. Besides island No. 1, another possible island site was plotted 6,250 ft. seaward from Punta Gorda in 64 ft. of water. Plans for the second island will await drilling results on the first.

Earlier this year, Richfield drilled several core-holes from its floating drilling barge in an attempt to evaluate the lease. In addition to exploring shallower pays, tests from the floating barge included a short production test at 4,200 ft. on one hole.

Canal Traffic Imperiled

British quit chartering tankers, insurance rates soar in wake of pilots' walkout; U. S. ready with emergency plan

AMERICAN officials are poised to pull the switch on emergency oil moves if the Suez Canal should close down in the wake of a new crisis over the week end.

Latest crisis was precipitated when 141 non-Egyptian pilots employed by the Suez Canal Co. started to walk out. With all gone, only about 90 experienced men would be on hand to handle canal shipping.

The canal company approved the mass walkout, and Egyptian officials decided not to interfere. But news of the plans brought these quick developments in shipping circles:

. . . **British oil importers** quit chartering tankers for Suez trip.

. . . **Underwriters boosted** insurance rates for the Suez area.

And in Washington:

. . . **Final plans were made** to bolster oil supplies of Western Europe.

A top official of the Office of Defense Mobilization disclosed that work has reached the point where the Government-Industry plan of action would be put into play with little delay.

. . . **U. S. got ready to take tankers** out of the reserve fleet.

Secretary of State Dulles declared these ships would haul oil around the Cape of Good Hope to Western Europe.

. . . **Officials said** domestic producers may be asked to provide 850,000 bbl. daily more of oil in the crisis.

One official estimated closing the canal would cut flow of Middle East oil from 1,500,000 to 800,000 bbl. daily. He said the U. S. producers could quickly provide 500,000 bbl. daily additional for Europe. Another 350,000 bbl. daily would be needed for coastal refineries to offset loss of Middle East crude.

. . . **U. S. informed Britain** it is opposed to use of force to meet anything less than an act of aggression by Egypt.

President Eisenhower told a news conference he is not sure this is the right time to refer the Suez problem to the United Nations. He added that the issue will be placed before the UN before any physical steps are taken.

. . . **ODM revealed** that a drop in canal movement has not occurred so far. The number of ships handled over the last 7 weeks since the canal was nationalized has been about normal for this time of year. But ODM officials admitted this situation could change.

Trouble ahead . . . First indication that canal traffic will slow down was the action of British oil importers.

British shippers quit chartering tankers for the canal trip. But they instructed vessels already under way to try and make the canal voyage before the walkout of European pilots was completed.

Chartering of ships in the United States for the canal trip has declined noticeably since Egypt's seizure of the canal.

The insurance underwriters for their part are now classing Egypt and the canal as an excluded area under war risk insurance. It now ranks along with Korea, Formosa, and China in this respect. Any vessel destined for Egypt or the canal has to pay even a higher premium than the ordinary war risk policy.

Old problems fade . . . The Suez crisis focused interest on two other knotty U. S. oil problems:

. . . **Supertankers** to make the longer haul around the cape. So far the administration has not given any thought to subsidies for building more of these big vessels.

. . . **Imports.** They would no longer be a problem if foreign supply is crippled. Imports for the year thus might be well below levels of the cabinet committee's formula *(see page 133)*.

Northern Natural Expanding

WASHINGTON.—Northern Natural Gas Co. has received Federal Power Commission authority to expand its system in the Midwest by 65,092,000 cu. ft. to 1,195,661,000 cu. ft. daily.

The projects include construction of 354 miles of pipeline and 18,640 hp. in compressor capacity. Northern will extend its system 163 miles from the Sioux Falls, S. D., area to Aberdeen, S. D., and will build 160 miles of branch lines to serve 20 new wholesale customers in South Dakota.

Northern will sell an additional 38,820,000 cu. ft. daily to present customers: 15,028,000 in the Aberdeen area; 4,146,000 to eight towns in Iowa; 12,000,000 to Allied Chemical & Dye Corp.'s Omaha ammonia plant (in addition to 4,380,000,000 cu. ft. annually sold on an interruptible basis); and 11,500,000 on an interruptible basis to St. Paul Ammonia Products Co., Pine Bend, Minn.

Pipeline BRIEFS

CALGARY.—Imperial Oil, Ltd., plans to expand the capacity of its crude-oil pipeline serving Winnipeg by almost one-third. Rate of flow through the 10-in. pipeline, which runs 75 miles from Gretna to Winnipeg, will be boosted by a $250,000 pumping station at Silver Plains, Man. Capacity of the line will be increased from 29,000 to 38,000 bbl. per day. Mannix-Gill, Ltd., of Calgary has been awarded the construction contract.

INDEPENDENCE, Kans.—Sinclair Pipe Line Co. plans to let contract early next year on the second section of a 300-mile crude-pipeline project from Jacksboro, Tex., to Houston. The first part, 151 miles of 18-in. line from Jacksboro to Teague, Tex., was completed earlier this year.

WASHINGTON.—A revised map of major natural-gas pipelines in the United States has been issued by the Federal Power Commission. It replaces the Government's December 1955 map. Pipeline systems of 120 companies are shown on the new map.

DEFIANCE, Ohio. — H. C. Price Co. has started laying a 48-mile section of a 22-in. line from here to Bridgman, Mich. The line is a spur line from the trunk line of American Louisiana pipeline, which runs from Louisiana to the Detroit area.

Also for Pipeliners . . .

Pipeliners are paying premium prices for new gas reserves in Beaver and Harper counties, Oklahoma (P. 120) . . . Northern Natural gets permission to expand system (P. 121) . . . Many at I.N.G.A.A. meeting think compromise gas bill will be worked out next year (P. 122) . . . Gas supply and markets for Florida pipeline lined up (P. 123) . . . FPC examiner has a new slant on handling rate-increase applications (P. 131) . . . Houston independents call meeting in Wise County to attack FPC's action in controversial pipeline case (P. 132) . . . New ditch padder is used on El Paso Natural project (P. 133) . . . Pacific Northwest provides escape for gas field shut in 28 years (P. 134) . . . Old and new methods used by Associated Pipe Line Contractors in laying 425-mile products line in Turkey (P. 136) . . .

Also the Journal's Thirtieth Annual Pipeline Number:

Eighty pages of valuable information ranging from pipeline tariffs and maps to all phases of operations, construction, and controls, starting on page 139.

Gas-Bill Hopes Rise

● Optimism pervades I.N.G.A.A. meeting. There's no proposed bill to consider, but producers, distributors, and pipeliners find a wide area of agreement

SAN ANTONIO.—New federal gas legislation to replace the vetoed Harris-Fulbright bill can be enacted early next year in a form acceptable to all segments of the industry if present informal cooperation between producers and distributors is continued.

This was the word passed both publicly and privately at the annual meeting of the Independent Natural Gas Association of America.

What's more, the broad outlines of a new bill were sketched by three speakers representing, respectively, gas distributors, pipelines, and producers.

And the surprising thing was that the three viewpoints were so nearly parallel that the intraindustry bitterness which surrounded the Harris-Fulbright bill promised to be a thing of the past.

Informal conferences between unofficial committees of producers and distributors, the speakers revealed, have resulted in rather general agreement on principles to be incorporated in the new bill. While all participants disclaim any authority to speak for their sections of the gas industry, optimism prevailed that the final proposal will meet widespread approval.

The areas of agreement are:

1. There must be legislation as soon as possible. The present effort of the Federal Power Commission to regulate producers' prices is chaotic and intolerable.

2. Producers' prices should not be related to cost or determined by any sort of public-utility formula. Distributing companies are said to be now completely convinced that a rate-base approach is ridiculous.

3. Producers must be assured adequate economic incentives to develop gas and sell it in interstate commerce. This means flexibility in price levels and freedom of contract.

4. All segments of the industry must have assurance that contract prices, once set, will not be changed by factors over which they have no control. This means:

For producers—no FPC power to roll back prices after a contract has been approved.

For pipelines—assurance that FPC will allow the full purchase price as part of the rate base.

For distributors—elimination of favored-nation and other indeterminate escalation clauses in field contracts.

5. Treat all gas as a commodity, no matter who produces it. This means that gas produced by a transmission company or its affiliate would be priced in the same manner as gas purchased from an independent producer.

6. Establish by law a "fair market value" standard to serve as a yardstick by which FPC can judge whether or not a field price is just and reasonable if a complaint is filed against it. The wording of this standard may be somewhat like that used in the original Harris bill.

7. Spell out in the law the types of contract provisions which are considered objectionable. This would ban favored-nation and spiral escalations, but permit stepups in price of stated amounts on stated dates, and passing on state production taxes.

8. New contracts would be filed with FPC and would become effective if FPC found no objectionable provisions and no party in interest complained that the price exceeded the fair market value. Once approved, FPC could not change the price and producers would be out of FPC jurisdiction, but escape clauses would not be operative. If not approved, the producer could exercise his escape clause and the contract would be void.

9. Old contracts containing indefinite escalation or other objectionable clauses would keep producers under FPC jurisdiction until the contracts had been renegotiated and approved by FPC as in the case of new contracts.

10. FPC would be required to accept or reject producer price contracts within a short period of time, in order to eliminate the "regulatory lag" and let all parties know the outcome promptly.

So far, these principles have not been reduced to the form of legislative language. There were suggestions that the bill-drafting may cause considerable controversy, but all at the meeting were cheered by the progress made to date.

Panel hopeful . . . The disclosures of the progress toward new legislation were made at a panel discussion on producer regulation.

Distribution companies were represented by Dean H. Mitchell, president of Northern Indiana Public Service Co. and president of the American Gas Association. Transmission lines were represented by George T. Naff, president of Texas Eastern Transmission Corp. Producers were represented by Charlton H. Lyons, Shreveport independent and president of the Mid-Continent Oil and Gas Association.

All three stated that they had no authority to speak for anyone but themselves, but they also expressed confidence that a bill along the lines suggested would gain general support from their segments of the industry. All pleaded for continued cooperation and mutual trust.

Mitchell particularly stressed the need to stop public attacks by one part of the industry against another part.

A prerequisite to a new bill, he said, is to convince the public that a minimum of regulation and a maximum of competition in gas-production will bring supply and demand into balance and stabilize prices at a reasonable level.

Naff said the transmission companies have sat on the sidelines while distributors and producers were discussing their problems, but that they have been kept informed of the progress and hope to be invited to take a hand in the final drafting.

While personally endorsing most of the agreements already tentatively reached, he warned that legislation cannot be enacted unless it is acceptable not only to a majority of producers, pipelines, and distributors, but also to the Federal Power Commission and to the Washington administration.

Lyons reported that distributors and producers have made much progress in understanding each other's business problems and legislative needs, and that both have retreated from some of the extreme positions they took previously. He urged that there be no public fight among the three parts of the industry which would permit left-wingers to capitalize on it to defeat legislation next year.

FPC pleads for help . . . Chairman Jerome Kuykendall of the Federal Power Commission, speaking at another session, avoided discussion of new legislation but pleaded for cooperation in administering the present law.

He asked that producers stop trying to get FPC to change the law or ignore court rulings, and said that producers' cases will only be delayed if their attorneys press unsound legal contentions which would certainly be reversed by the courts.

"We expect members of our staff who are in your offices to show due understanding of your need to carry on your business without undue inconvenience and disclosure of records and information which need not be disclosed. On the other hand, we find that some companies have in force procedures for protecting the privacy of their records,

which cause what appears to us undue delay.

"All of you are respectfully urged to maintain procedures which will permit our staff members to obtain necessary records as speedily as possible, without in any way jeopardizing your own proper interests."

Florida Gas Assured

Supply deals are completed for proposed big-inch line

WASHINGTON. — Plans for piping the first natural gas into Florida got a boost last week when major contracts were signed assuring supplies and markets.

The big project is currently the subject of renewed hearings before the Federal Power Commission, which must issue a certificate before the line can be started. The 24-in. pipeline from Texas to Florida would be a joint effort of Coastal Transmission Corp. and Houston Texas Gas & Oil Corp. Coastal would build the portion of line from the Lower Rio Grande region of Texas to Baton Rouge, La. Houston would build the line from Baton Rouge to Miami.

Coastal last week announced it had completed gas-supply contracts for more than 100 per cent of the 20-year gas requirements of the pipeline. Proved reserves under contracts now total more than 1,850 billion cubic feet. Coastal will supply gas to Houston at the Baton Rouge connection.

Houston in turn signed a contract to supply Florida Power & Light Co., which will market the gas. Florida Power & Light also completed supply contracts with Sun Oil Co., Magnolia Petroleum Co., and LaGloria Oil & Gas Co. They cover 100 million cubic feet of gas for 20 years.

Houston also executed a service agreement with People's Water & Gas Co. and the Tampa Gas Co., a unit of People's, for marketing the gas in Florida.

Deal Made for Offshore Play

LOS ANGELES.—Newmont Oil Co. has taken a 50 per cent interest in Monterey Oil Co.'s California offshore operations.

Under the agreement, Newmont Oil, a wholly owned subsidiary of Newmont Mining Corp., will share equally in Monterey's 50 per cent interest in a joint exploration program with The Texas Co. The Monterey-Texas pact calls for Monterey to act as operator in areas south of the Ventura-Los Angeles County line while Texaco acts as operator north of that line.

watching WASHINGTON

. . . with Bertram F. Linz

Imports free-for-all coming up . . .

HEARINGS next month on the plea of domestic producers for enforced oil import controls are likely to turn into a prolonged free-for-all.

Everybody will be allowed to get into the act. And the Office of Defense Mobilization already has indications that a lot of people will want a part. Officials refuse even to speculate on how long the hearings may run.

The producers, of course, will be given top billing on the witness list. Officials of importing companies will be heard. Jobbers' organizations and consumer groups who, with the importers, will make up the opposition, also are asking for time.

Only one thing is certain. The hearings will be held, no matter what the cabinet fuels committee decides this month on the basis of a review of the present import picture by its task force.

If the committee decides that the formula it wrote last year was right and imports now are excessive, it will of course add strength to the producers' arguments for formal controls. But there is an impression in some circles that the committee may find that conditions have so changed since 1954 that a new formula, increasing allowable Middle East crude imports, is in order. Either way, the domestic interests will be given their day in court.

"Natural" rubber perks up interest . . .

GOVERNMENT agencies are closely watching the progress of a new synthetic "natural" rubber announced last year.

The Defense Department has placed orders for a small number of tires made from the new rubber, and will give them intensive field tests. The Office of Defense Mobilization has granted a certificate for accelerated tax amortization to one of the three companies which have announced the synthesis of the new polyisoprene polymer.

"We can all be assured that the federal agencies concerned have their eye on this problem and that continuing encouragement will be given to private industry to further this new technological development," according to Alan T. Waterman, director of the National Science Foundation.

The foundation has followed recommendations of a special commission for rubber research. It is closing out its research contracts and adopting a program of support for basic research in the field of high polymers. It has so far approved 17 grants amounting to $687,000 for research in this field.

Revolutionary marine engines just ahead? . . .

MARITIME Administration experiments may set off a revolution in the field of ship fuels.

New engines are being built into four Liberty merchant ships to test as many methods of propulsion. One was given a new steam turbine. It showed a speed of over 15 knots in sea trials. A second has new geared diesel engines, getting 17½ knots. A third went to sea last week with a gas turbine. The last experiment will be with a free piston gas generator-turbine plant. It will be tried out in December.

The three vessels so far converted are being operated by U. S. Lines. Two are in the South Atlantic-European service. The other is under general agency agreement and assigned to the Military Sea Transport Service.

The Maritime Administration isn't aiming at any overnight change in power for merchant vessels generally. Its plan is to find out the possibilities of modernizing the Government's ships for emergency use. But the tests will show whether new types of engines are practical and economical. If successful, the results would quickly be reflected in private shipping.

Caution Flag Hoisted in Booming Bisti

- **Field helped make Four Corners area hottest in U. S., now covers over 30 sections and still growing**
- **But painful memory of overdrilling at Spraberry is causing operators to ease up on development**

Robert J. Enright
Southwest District Editor

FARMINGTON, N. M.—There may be trouble ahead for producers in the San Juan basin's biggest and one of its newest oil fields.

It's the burgeoning Bisti pool south of Farmington, San Juan County, in the far northwest corner of the state. The discovery switched major exploratory interest to the area. But there are signs that everything is not so rosy at it might seem.

Bisti was probably the fastest-growing field in the county during the summer, and last week boasted 55 wells and a reasonably proved producing area of at least 20,000 acres.

The lean giant now stretches about 15 miles in a general west northwest-east southeast direction and ranges up to 4 miles wide.

The field discovery was completed by El Paso Natural Gas Co. at its 1 Kelly-State (A on map) in Section 16-25n-12w in 1955. Significance of the strike wasn't apparent, however, until British-American Oil Producing Co. brought in its 1 Marye (B on map) in Section 1-25n-13w early this spring. This was the well which kicked off the big drilling pay.

At last count Sunray Mid-Continent Oil Co. led in completions with 20, El Paso and British-American had 9 apiece, and Amerada Petroleum Corp. followed with 7. The remainder are owned by Phillips Petroleum Co., Shell Oil Co., and others. British-American is the biggest acreage holder by far.

Wells generally have been completed for from 200 to 700 bbl. daily, with a few topping 1,000 bbl.

Development in recent weeks, however, following the summer spurt, has slowed down almost to a standstill. This is due in part to lack of a sufficient outlet. Output is restricted by the available market to 30 bbl. a day per well. Diversion of scarce tubing and casing to more pressing projects has had some effect, too.

But there are also other, less obvious reasons.

Another Spraberry? . . . Most Bisti operators now are pausing to take a good close look at this big reservoir before deciding how best to develop and produce it.

The field in many ways resembles West Texas' Spraberry Trend Area field. The entire industry learned a lesson there from the bitter experience of a few operators who went all-out too quickly.

Producers in the field generally feel that the Gallup pay is better than Spraberry, but they're proceeding cautiously just the same. Significantly, no 40-acre locations are being staked now.

Enough wells have been completed and reservoir data gleaned from them to make it virtually certain that Bisti, like Spraberry, is a big stratigraphic trap producing solely by a solution-gas type drive—the poorest natural form of production energy.

The Gallup sand pay is much like the Cardium in Canada's giant Pembina field. It looks like tombstone and is very tight. Porosity ranges from zero to about 20 per cent. Permeability fluctuates drastically from about 374 md. to zero. As in Spraberry, producers feel Gallup oil lies mostly in natural fractures.

Fracturing is essential to establish production in most cases. Gallup cores just stain the hand. A perplexed veteran with one of the largest Bisti operators said recently after bringing in a good well that he'd "plugged many a well with better looking pay!"

Contours of Micro-Log pay show that the best Gallup production comes from a belt lying east and west in the center of the field. There is about 20 ft. of Micro-Log pay in this area. Net pay thickness diminishes to the north and south as permeability and porosity decrease and sands change to shales.

Field limits . . . Eventual field limits almost certainly will be defined around most of the perimeter by pinching out porosity and permeability.

British-American's 2 Ross Federal (C on map) on the south side appears to have been completed near this boundary where the Gallup becomes so tight as to be noncommercial. This well was completed for only 18 bbl. daily on the pump. Engineers for this firm feel that Gallup pay with less than 5 per cent porosity will not produce oil in commercial quantity.

About 4½ miles west of this well, Magnolia Petroleum Co. found the Gallup even tighter at its 1 Federal-Postelle (D on map). The company finally plugged the well after exhaustive efforts to obtain production.

The limits of the field have not as yet been defined in any direction, but operators are getting a rough idea of how far they can prudently go to the north and south. Best bet for a sizable extension to the present field area is believed to be to the southeast.

Development already has been extended 2½ miles east by Shell Oil Co. into Sections 24 and 25 25n-12w.

Drilling in the area has turned up what is apparently a new Gallup field, although some geologists think it may be linked with Bisti later. Ted White is completing the Gallup wildcat 7 miles south of the original Bisti discovery. The well (SW SW Section 13-24n-12w), has yielded 9 bbl. of oil per hour on pump tests. If the new area is joined with Bisti, it will add several more sections to the growing field.

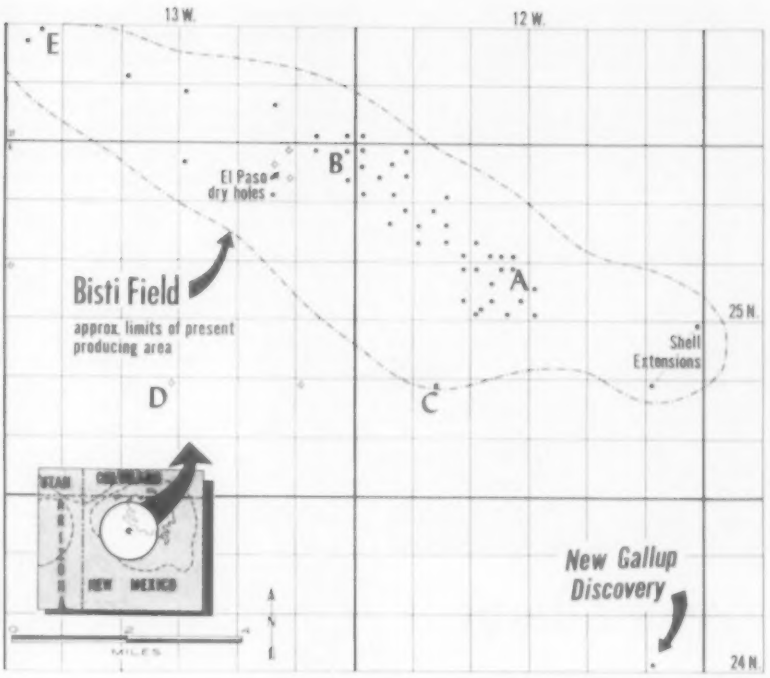
There is also a possibility that the field may be extended to the west but available evidence indicates porosity is diminishing in this direction, too. The westernmost well in the field is C. M. & W. Drilling Co.'s 1 Elliott (E on map) in Section 30-26n-13w. It was believed at first that this well would make a good oiler, but at last report it was down to swabbing only 3 bbl. an hour.

Clouding the picture in the west-central portion of the field are three dry holes drilled by El Paso in Section 2-25n-13w. These dusters are located in the next section west of British-American's first prolific wells and in the central belt considered the field's best producing area.

Recovery prospects . . . First estimates of recovery from the Gallup, as in most new fields, vary considerably. The highest prediction given the Journal was about 2,500 to 3,000 bbl. per acre. Even this is low in comparison with many other reservoirs.

A more realistic estimate, most operators think, would be around 2,000 to 2,500 bbl. per acre. Some, even more conservative, think this would be about right only in the better portions of the field. They think this is too high for the field generally.

One of the largest operators expects recovery to be 1,000,000 to 1,250,000 bbl. per square mile. This would indicate that the field, considering only the area now reasonably well proved, will eventually produce 30,000,000



bbl. of oil or more. Though large, this figure still isn't very impressive for a field taking in such a large area.

Spacing in the northeastern portion of the pool, which has seen the heaviest development so far, is on 80 acres.

To the west, development has been much more sparse. British-American, which owns almost all the acreage over what appears to be the western half of the field, is proceeding gingerly. It is now drilling only one well per square mile until it sees how Gallup production is going to hold up. B. A. will probably drill only about four or five more locations before the year's end.

The producers are certain eventually to have a formidable problem in disposing of the field's gas output, much as did Spraberry operators a few years ago. To utilize it will mean laying an expensive low-pressure gathering system over a large area.

Fracturing expense heavy . . . Gallup pay is producing from about 4,800 ft. at the east end of the field, deepening to about 5,000 ft. to the west.

Over most of the field there are three Gallup zones. If there is any Micro-Log pay at all, it is in the shallowest of the three. And in some wells, the zone flows before fracturing.

It costs about $40,000 to complete a dry hole in the Gallup, and from $75,000 to $100,000 to bring in a producer. Much of the expense is incurred in multiple fracture treatments of the tight sand.

Trucking cost high, too . . . Prospects are that Bisti won't find an outlet for all the crude it could produce for a long time. Drilling is expected to continue to lag because of the limited outlet.

The field is producing only about 1,500 bbl. daily. It is capable of 10 times as much.

The only market outlet at present is El Paso Natural Gas Products Co.'s 3,000-bbl. Prewitt, N. M., refinery 45 miles east of Gallup. The oil is hauled by small independent truckers to El Paso's Lybrook pump station, where it enters a line to the refinery. Trucking charges are stiff, averaging about 51 cents a barrel. The oil grades about 36° gravity and brings $2.84 a barrel.

Some help coming . . . Producers likely will find no relief for at least another year.

El Paso is now starting construction of a new 6,500-bbl. daily refinery at Ciniza, 17 miles east of Gallup. This plant, slated for completion in the fall of 1957, likely will take the bulk of its crude from Bisti.

El Paso also has indicated that it has designed the refinery to permit easy expansion should the need arise.

Some further help may come from a new pipeline which the Pacific Northwest Pipeline Corp. organization plans to build from the Salt Lake City refining center 350 miles to the northwest. Capacity would be about 15,000 bbl. but about half of this would be filled by products from Pacific Northwest's gasoline plant at Ignacio, Colo. The remaining capacity would be split mainly between Bisti and the growing Aneth producing area in southeastern Utah.

This line also is scheduled to go into operation in the fall of 1957.

All told, however, these outlets would provide a market for only around 10,000 bbl. of Bisti oil at most—far below the field's potential.

Field operators, at least for now, are inclined to write off the possibility now being discussed on the West Coast of a line to the Four Corners area *(The Oil and Gas Journal, September 10, page 83)*. It would be several years, if ever, one said, before Four Corners oil reserves could justify a large-diameter line of such length.

Other problems, too . . . Along with worrying over market outlet and well payout, Bisti operators have other aggravating problems.

Lack of an adequate water supply in this arid region is one. Demands have proved too much for a small stream coursing through the field, and water wells are now being drilled.

Paraffin accumulation in many wells is causing trouble.

Overshadowing these headaches is another which isn't immediate but which is nonetheless causing considerable concern. That is: What will operators do when pressure drops and gas-oil ratios begin to soar?

Opinion is divided as to whether the pay is suited to any type of pressure-maintenance operation.

An official for one of the larger operators feels it is not. A water flood started early in the life of the field, he thinks, is out of the question due to the Gallup's wide permeability fluctuations. The water would merely channel through the more permeable portions of the sand, bypassing and losing all oil in the remainder of the pay.

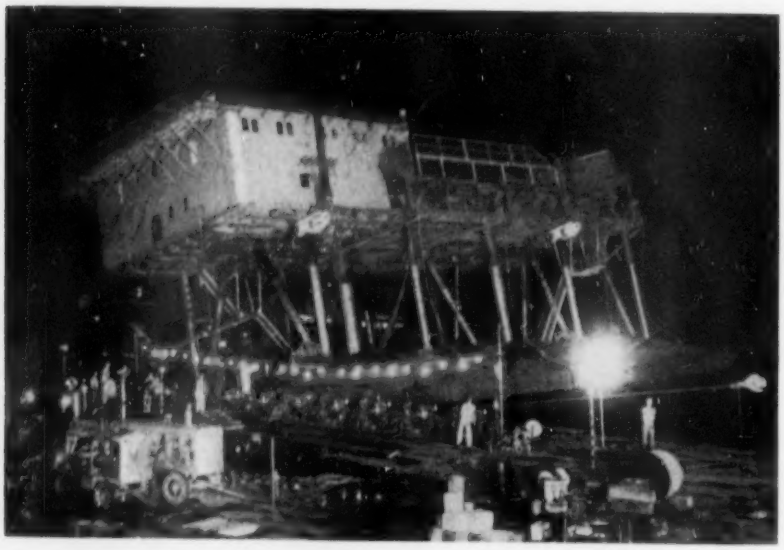
A water flood might be feasible later on, this official feels, after the field has been almost depleted and after pressure has fallen well below the bubble point.

Basin interest hiked . . . But Bisti is a big field, no matter how you look at it.

Together with Aneth field to the northwest, it has put the Four Corners area, the Rocky Mountain area's major gas-producing region, on the oil map in a big way. The two discoveries have provided the spark which appears certain to place Four Corners near the top in national exploratory interest during this year and probably many more.

They have been the stimulus for such new wildcat programs as that recently announced by Sinclair Oil & Gas Co. which soon will drill the first of 24 tests on the west side of the San Juan basin.

Crane Tugs at Capsized Barge . .



. . By Night It's Flipped Upright

NEW ORLEANS.—A dramatic salvage operation has righted the big drilling barge which capsized in the Mississippi River near here August 10.

The vessel, which suddenly turned upside down as it was nearing completion at the yard of Avondale Marine Ways, Inc., appeared to have been damaged relatively little. Plans call for reconditioning the barge and much of the drilling equipment which overturned in 95-ft. water.

Loss runs high . . . However, no effort is being made to salvage the derrick, which broke off when the vessel overturned. Also still at the bottom of the river are drill pipe and casing. They had been loaded on the deck shortly before the vessel flopped over.

The salvage operation is expected to cost more than $300,000. The barge, being built for Southeastern Drilling Co., was valued at about $1,500,000. Drilling equipment which went over with it was valued at an additional $1,000,000 or more. More than $1,339,000 of the loss was covered by insurance *(The Oil and Gas Journal, September 3, page 66).*

How job achieved . . . Uprighting the 2,500-ton vessel required close co-ordination of a huge derrick barge, shore lines, and ballast pumps.

Two giant hooks were attached to the lower portion of the barge by divers. An 800-ton capacity derrick barge, said to be the largest operating in the gulf area, lifted on these hooks.

Meanwhile, two additional sets of cables had been extended under the capsized barge and attached to the shore side of the vessel. Two shore-based engines pulled simultaneously on cables attached to the river side.

The lifting operation started about 10 a.m. September 6, as illustrated in the photo at top. The other picture, taken about 8 p.m., shows the huge barge easing into an upright position.

The barge had been kept afloat nearly a month with just its lower hull above the water.

Lifting was done from the river side of the vessel. As that side of the hull started rising from the water, the side nearer shore began to sink. When the barge had been turned about 100° ballast was reversed, with water being pumped into the top tanks and air into the submerged tanks.

Sohio Offers Superpremium

CLEVELAND. — Standard Oil Co. (Ohio) will start marketing a superpremium gasoline in Ohio October 1.

Sohio went along with other Midwest marketers in voting against a third grade which some companies are adopting in the East Coast, southeast, and Gulf Coast areas.

The company's superpremium boron gasoline will sell for 4 cents a gallon above its regular grade. The octane number was not disclosed. But Sohio said it would meet requirements of next year's high-compression engines and would offer "better control of surface ignition than has been possible with any gasoline ever before available in Ohio."

Sohio also said it is upgrading its regular gasoline.

Alberta Crude to Japan

VANCOUVER.—Alberta crude may be shipped to Japan for the first time this month.

Negotiations for a 120,000-bbl. shipment are in progress with a Japanese buyer. A tanker now on the California coast would pick up the Canadian crude here. The deal does not anticipate any other shipments.

More than a million barrels of Alberta crude was shipped to California refiners on a spot basis the first half of 1956. The California market was cracked for the first time January 1.

Cash Fight Settled

State, Long Beach split up impounded tidelands money

LONG BEACH.—Superior Judge A. Curtis Smith has signed a judgment and decree which may end the long court battle between the city of Long Beach and the State of California over ownership of $170 million in impounded tidelands oil revenue. The agreement may be contested, however.

Under the compromise settlement, Long Beach immediately will pay $120 million to the state from the funds. In the future, the state and city will equally divide the oil revenues. The state will receive all the dry-gas income. Before the income is divided, certain amounts will be deducted to pay for subsidence work in Long Beach harbor.

The compromise followed a court decision last year that funds freed by the state legislature from terms of a 1911 grant to the city should go to the state and not Long Beach. The state then filed suit to recover the funds being held by the city.

Before this case could come to court, the state and city worked out the agreement approved by superior court.

The court session during which the settlement was signed by Judge Smith produced one bitter moment. Attorney Theodore Gabrielson, long a court foe of Long Beach, attacked the settlement as a "fraud between a dishonest trustee and a negligent attorney general." He announced he will try to block the settlement in the state supreme court.

Union Absorbs Los Nietos

LOS ANGELES.—One of California's pioneer oil companies was officially dropped from the records last week when the Los Nietos Co. was dissolved and all its assets and liabilities taken over by Union Oil Co.

Los Nietos has been a wholly owned subsidiary of Union since October 1949, but had continued to operate under the original Los Nietos name.

The company was founded more than 50 years ago by the late Edward L. Doheny in a move to consolidate his vast oil holdings into one company for the benefit of his five grandchildren.

Union purchased the company in 1949 for $22,400,000 in cash and 600,000 shares of Union stock. At that time, Los Nietos assets consisted of 48,000,000 bbl. of crude reserves in California, Texas, and Canada.

Processing BRIEFS

BAYTOWN, Tex.—An independent union representing some 4,200 workers at Humble Oil & Refining Co.'s Baytown refinery has decided to call a strike vote. Date of the vote is to be set by the executive council of the Baytown Employes Federation.

The union last month filed charges of unfair labor practices against Humble, accusing the company of refusing to bargain collectively with authorized union representatives.

ASHLAND, Ky. — Ashland Oil & Refining Co. plans to build an aromatics plant and other auxiliary equipment at its 30,000-bbl. daily refinery at Buffalo, N. Y. The new plant will have capacity of 1,370 bbl. daily of benzene, toluene, xylene, and other petrochemicals. Feed stock for the unit will come from a 7,500-bbl. daily catalytic reforming unit now under construction.

LOS ANGELES. — Workmen are putting finishing touches on a 4,000-bbl. daily fluid coker at the Bakersfield refinery of Bankline Oil Co. The new unit is scheduled to be on stream by November 1. The coker will convert topped crude and thermally cracked fuel oil to coke, gasoline, gas, and gas oil. The gas oil will be cracked thermally to recover more gasoline. Fluor Corp., Ltd., had the engineering and construction contract.

LOS ANGELES. — Sunset Interna-tional Petroleum Corp. plans an immediate expansion of thermal-cracking capacity at its 9,000-bbl. daily refinery at Torrance. New installations costing about $200,000 will boost cracking capacity from 2,700 bbl. daily to 3,700 bbl. The new company, resulting from merger of Sunset Oil Co. and International Mining Corp., also plans stepped-up exploration programs in California and Canada.

AUSTIN. — The Texas Railroad Commission has approved applications for L.P.G. underground storage projects made by Shell Oil Co., Magnolia Petroleum Co., and Pure Oil Co.

Shell will leach a 200,000-bbl. cavity out of the tremendous Salvado salt formation under site of its TXL natural-gasoline plant in Ector County. Magnolia will create two 50,000-bbl. cavities in the salt between 1,700 and 2,700 ft. under its Midland, Tex., tank farm. Pure will set up a 200,000-bbl. cavity in the Big Hill salt dome in Jefferson County on the Gulf Coast.

VANCOUVER, B. C.—Imperial Oil, Ltd., has awarded a contract to Canadian Bechtel, Ltd., to build a 5,000-bbl. per day Powerforming unit at its 23,000-bbl. refinery at Ioco near here. Included will be a prefactionator and a Hydrofiner to pretreat the catalytic reformer feed stock.

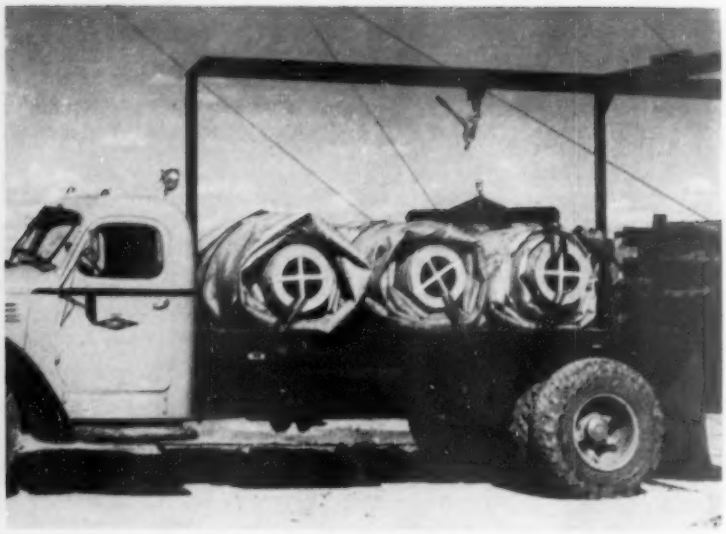
The $4,000,000 project also calls for new storage tanks, piping, fire-protection equipment, roads, and special catalyst-handling equipment. Initial operation of the new units is scheduled for September 1957. Construction will get under way next spring.

ATRECO, Tex. — Atlantic Refining Co. has been granted a certificate of necessity covering part of the cost of a new Catforming unit to be built at the 61,000-bbl. per day refinery here. The Office of Defense Mobilization will permit Atlantic rapid amortization on 65 per cent of $4,316,700 and 45 per cent of $230,300.

Also for Refiners . . .

Journal predicts jet-fuel demand will outstrip avgas requirements within the next year (P. 116) . . . Refiners heard some of the problems expected during the "Jet Age" at the N.P.A. meeting (P. 119) . . . Standard of Ohio has decided to market a beefed-up premium rather than a third grade . . . Negotiations are being made to ship 120,000 bbl. of Canadian crude to Japan (P. 126) . . . Du Pont survey reveals road octanes are only 1 number below research ratings . . . Gulf starts up a new visbreaker that will handle heavier residual fractions (P. 129) . . . Independent Refiners Association and 13 firms ask right to testify on proposed sale of U.O.P. stock (P. 130) . . .

PLUS THESE FEATURES: When should a refiner handle its own maintenance, and when should it be contracted? (P. 280) . . . W. L. Nelson answers questions on effect of charge stock on catalytic cracking (P. 289) . . . Performance comparison of industrial cycles (P. 291) . . .



Steel tanks are cumbersome, but . . . Roll-up rubber tanks make moving a simple chore.

Too, they unroll and connect easily and . . . They're soon ready for work. That's why . . .

In the rugged San Juan basin . . .

Rubber Tanks Cut Fracturing Costs

TULSA.—Dowell Incorporated is using flexible rubber storage tanks in its formation-fracturing services in the San Juan basin. They are proving a quick and economical answer to transportation and storage problems involved in the rugged terrain of the Four Corners area.

The rubber tanks are replacing steel tanks for temporary storage of water, crude, and refined oils used by Dowell in its various well-stimulation processes. They are built of rubberized nylon. They are strong, flexible, and oil and abrasion resistant. Each 15,000-gal. tank, when filled, is 45 ft. long, 11 ft. wide, and nearly 6 ft. high.

Moving the old steel tanks from well to well for temporary storage was expensive and time consuming. The rubber tank, in contrast, with all its piping and valves, weighs about 1,350 lb. They can be rolled up like sleeping bags. Six can be carried easily on a small truck equipped with simple hoisting gear for quick handling.

Other features: Internal flexible stabilizers to prevent rolling, pressure-release system preventing rupturing by overfilling and allowing rapid emptying, and a repair kit which allows on-the-job mending. Built by Firestone Tire & Rubber Co., the tanks cost more than steel tanks. But this is more than offset by savings in transportation, handling, and maintenance.

Road Octanes Hold Up

Du Pont tests show road octanes are one number lower than research; sensitivity spread, however, still big

NEW YORK.—Summer gasoline marketed in 11 selected U. S. cities last July averaged about 95.7 road octanes for premium and 88.1 road octanes for regular grade.

The result of a periodic survey conducted by the Du Pont Co. shows a road-octane depreciation from research ratings of about 1 number for each grade. Du Pont's road testing is done with six 1956 and 1955 model cars.

They were selected as representative of those having the more critical octane requirements.

Premium-grade samples are tested in a 1956 Buick 70 Dynaflow, a 1956 Cadillac 62 Hydra-Matic and a 1956 Lincoln Turbo-Drive. A 1955 Chevrolet V-8 and a 1955 Plymouth V-8 both with synchromesh transmissions and a 1956 Ford Fordomatic are used to test regular-grade samples.

Altogether, 48 regular-grade samples and 50 premium-grade samples are tested in this fleet. Road tests are conducted at Deepwater, N. J., by the Petroleum Laboratory of Du Pont's petroleum chemicals division.

Sensitivity, or the spread between research and motor octanes, ranged around 10 numbers for premium and 6-7 numbers for regular. But the spread between research and road octanes, or depreciation, was much less. Among the premium samples tested, sensitivity ranged from 7.6 for a Denver sample to 12.6 for a sample obtained in Los Angeles. One premium sample from Denver showed a road-octane rating 0.3 number higher than research. The greatest road-octane depreciation was noted in a Los Angeles sample which showed a research-road octane spread of 2.3 numbers.

For regular grade, the sensitivity ranged from a low of 3.4 in Denver and Oklahoma, to a high of 8.6 in the Cleveland-Detroit area. One regular grade Denver sample tested higher on the road by 0.1 number, than in the research test. The greatest depreciation showed up in a Chicago sample which reduced research rating by 2.7 numbers.

Some correlation of road-octane depreciation with research octane occurs at the lower research-octane ranges. Here the spread generally decreases with research-octane rating for both regular and premium grades. But plotting road-octane depreciation vs. research rating in the 86-92-RON range for regular samples and the 96-98-RON premium range gives a wide scattering of results. It shows no relationship of octane rating with road depreciation.

Here's How Gasoline Octanes Stack Up

PREMIUM GRADE

	Research ON	Motor ON	Sensitivity RON-MON	Road ON	Road octane depreciation RON-RdON
Chicago	97.2	87.1	10.1	96.0	1.2
Cleveland-Detroit	96.8	86.5	10.3	95.7	1.1
New York City	97.4	87.2	10.2	96.4	1.0
Philadelphia	96.8	86.8	10.0	95.7	1.1
Denver	94.0	85.4	8.6	94.0	0.0
Houston	97.8	87.1	10.7	96.4	1.4
Los Angeles	96.8	85.5	11.3	95.2	1.6
San Francisco	96.7	85.9	10.8	96.0	0.7
Tulsa-Oklahoma City	96.2	86.7	9.5	95.3	0.9
Average, all samples	**96.7**	**86.6**	**10.1**	**95.7**	**1.0**

REGULAR GRADE

	Research ON	Motor ON	Sensitivity RON-MON	Road ON	Road octane depreciation RON-RdON
Chicago	90.6	83.7	6.9	89.3	1.3
Cleveland-Detroit	90.2	83.0	7.2	88.9	1.3
New York City	91.1	84.9	6.2	89.9	1.2
Philadelphia	92.1	84.8	7.3	90.8	1.3
Denver	85.7	81.0	4.7	84.8	0.9
Houston	89.6	82.1	7.5	87.9	1.7
Los Angeles	87.0	79.6	7.4	86.2	0.8
San Francisco	86.7	80.9	5.8	86.4	0.3
Tulsa-Oklahoma City	88.3	83.7	4.6	87.2	1.1
Average, all samples	**89.2**	**82.8**	**6.4**	**88.1**	**1.1**

Plant Spruced Up

Gulf dressing up refinery in pastels for the public

PHILADELPHIA.—This new 22,500-bbl. per day visbreaker was placed on stream at Gulf Oil Corp.'s Philadelphia refinery 2 weeks ago. It differs from other visbreakers in two respects.

Incorporating new patented improvements, it will charge heavier residual fractions than others, yielding 7,500 bbl. per day of gasoline and No. 2 heating oil. It is also probably the prettiest visbreaker ever built. It blends two shades of gray with bright red safety trim to contrast with other equipment and buildings in the refinery which will be painted with pastels of pink, yellow, blue, and green.

The visbreaker and the alkylation unit at the 183,000-bbl. per day refinery are the first examples of what Gulf calls "Operation Rainbow." This beautification project will convert all of the plant's processing units, plus the tankage in its nearby 2,900,000-bbl. crude storage area, into harmonizing color. In addition to the pastels, spherical tankage will sport bright blue, orange, green, and chartreuse coats of new paint.

The entire area will be floodlighted at night to provide a round-the-clock view of the East Coast's largest refinery.

It is very much in the public eye, since more than 40,000 vehicles pass within sight of it every day. Many of them cross a high bridge over the Schuylkill River which gives motorists a bird's eye view of the entire plant.

Refiners Go To Court

Independents' association, 13 firms tell why they oppose U.O.P. sale; A.C.S., Guaranty Trust try to block motion

NEW YORK.—Independent refiners last week made their bid to be heard when the proposed sale of Universal Oil Products Co. comes up for hearings. The group opposes the sale on the grounds that it will affect them adversely as licensees of U.O.P. processes and recipients of U.O.P. services.

Representatives of the Independent Refiners Association of America and 13 companies appeared September 10 before state Supreme Court Judge Jacob Markowitz. They asked that he admit them to present their case before the referee, William J. O'Shea. They claimed they should be properly considered as "nonmonetary" beneficiaries of the trust as now set up. And as recipients of these benefits, they claim they have a right to be heard.

The independents feel that the court cannot decide whether to permit the trustee, Guaranty Trust Co. of New York, to sell U.O.P. securities without full knowledge of all sides of the controversy. If Guaranty Trust is granted the right to sell, they feel that the trustee will be free to sell to whomever it sees fit without further jurisdiction. If the request to sell U.O.P. had implied court control over the purchaser, the independents stated, they would not be objecting at this point.

Guaranty Trust's legal representative countered with the view that the independents are nowhere mentioned as beneficiaries under the trust and have no rights to interfere.

Further, the trustee reported that if the independents are granted permission to be heard, the implication that they are beneficiaries would threaten to invalidate the trust itself.

A.C.S. joins Guaranty . . . Guaranty Trust said that the independents' claims of adverse effects from the sale of U.O.P. are pure speculation, and admits to no beneficial interest on their part.

The American Chemical Society, which receives U.O.P. income for the Petroleum Research Fund under the trust, joined Guaranty Trust in asking the court to deny the independents' motion to intervene. The A.C.S. legal representative stated that the society is also concerned over the threat to the validity of the trust.

No help from state . . . The New York attorney general stated his office cannot represent the independents in the case since they are private enterprises conducted for profit.

The attorney general is on record as having no objection to the sale, but at the same time has not stated that he consents. Further, the attorney general's representative said the office had no objection to intervention of the refiners in the case.

Decision on whether to permit independents a voice in the hearing before the referee will be at the discretion of the court. No date has yet been set for such a hearing. However, it was generally agreed that time is vital, and the case is expected to move along promptly this fall.

Refiners represented at the court hearing were Aurora Gasoline Co., Eastern States Petroleum Co., Inc., Elk Refining Co., Frontier Refining Co., Great Northern Oil Co., Ingram Oil & Refining Co., Kendall Refining Co., National Cooperative Refining Association, Pennzoil Division of South Penn Oil Co., Quaker State Oil Refining Corp., Rock Island Refining Corp., United Refining Co., and Vickers Petroleum Co., Inc.

SOCONY MOBIL MOVES from office once occupied by John D. Rockefeller, Sr.

Socony Changes Its Famous Address

NEW YORK. — Socony Mobil Oil Co., Inc., is moving this month after doing business at 26 Broadway, in New York's famous Battery, for 71 years.

The move of one of the world's largest oil companies is being made on Friday nights and weekends to avoid becoming hopelessly entangled in New York's traffic. It will take 15 vans making 1,000 loads.

Communications during the move are provided by special telephone lines connecting the old building with the new headquarters at 150 East 42nd Street.

The old building near the foot of Manhattan has long been a landmark. It was the office of John D. Rockefeller, Sr. At one time 26 Broadway reputedly was the second best known street address in the world, next to 10 Downing Street, home of British prime ministers.

NEW HOME is stainless steel skyscraper.

Socony's new home also is distinctive. The 45-story structure is the world's first stainless steel-covered skyscraper. Socony leases 25 floors, covering 600,000 sq. ft., from Galbreath Corp. under a 25-year agreement.

Royalty Control Looms

FPC decision may mean thousands of royalty owners of gas production must submit to federal regulation, too

WASHINGTON. — Thousands of owners of royalty interests in gas production face the threat of being roped into federal control under the Natural Gas Act.

The Federal Power Commission has ordered two owners of royalty interests to file application for sales certificates. This is seen as a possible first step in the direction of federal control.

The FPC did not disclose reasons for its action. Both cases involve companies which reserved a one-eighth interest in production from leases. But both sell their gas to the lessee.

The action of the majority brought a vigorous dissent from Commissioner Seaborn L. Digby. He foresaw a breakdown of the normal relationship between royalty owners and producers if the latter are brought under federal control. The Texas Independent Producers and Royalty Owners Association said it would seek a review.

A. E. Herrmann, president of TIPRO, estimated that extension of federal regulation would bring "several hundred thousand" holders of royalty interests under FPC. He declared the situation illustrates "the ridiculousness of trying to regulate individuals as 'natural-gas company' utilities."

How it started . . . The new furor began when the FPC accepted for filing the rate schedule of Northern Natural Gas Producing Co. and the Elk River Coal & Lumber Co. and called for filing of sales applications.

Northern sells its royalty gas to its parent, Northern Natural Gas Co. Elk River sells its gas to Equitable Gas Co.

Digby, who called his dissent also a "protest," admitted the two cases had "unusual" features. But, he said, study would show they are subject only to the same test as other royalty gas where leases provide that the royalty interest shall be paid for by the lessee at the market price at the well. This is true of the vast majority of commercial oil and gas leases.

The only test of jurisdiction, Digby asserted, is the Natural Gas Act "and not the particular circumstances surrounding the transaction."

Far reaching results . . . Digby warned if the decision in the current case becomes a policy of FPC "it will mean that the commission is taking jurisdiction over a major portion of all the royalty owners whose gas is being sold in interstate commerce for resale."

He also showed these possibilities:

. . . Royalty owners would have to apply to the FPC before they could enforce lease provisions calling for payment of market value of gas at the well.

. . . Commerce and trade in royalty interest would be crippled.

Digby declared other members of the commission are overlooking a provision of the Natural Gas Act which holds it is the "business" of transporting and selling gas that is affected with public interest. He argued that acceptance of royalty payment in gas does not place the royalty owner in the business category.

$1 Million-plus sunk offshore . . .

. . . Dry-Hole Cost Staggering

HOUSTON.—Two offshore oil operators last week let the public in on what normally is a closely guarded secret—the cost of a dry hole.

Shell Oil Co. and Continental Oil Co. revealed that their unsuccessful wildcat 63 miles southeast of Galveston cost "nearly $1,000,000." Investment in the dry hole averaged nearly $20,000 per day for the 51-day drilling period.

"This figure does not include cost of the lease or advance exploration expenses," Shell explained. "Some idea of the cost of marine geophysical exploration can be derived from the fact that expense of operating an offshore seismic crew may run to more than $2,000 daily."

Other costs high . . . The two companies spent an additional $30,000 for surveying, soil boring, and other operations before drilling began.

"Major factor in this unusually high cost was the necessity of locating the well site by elaborate electronic means rather than by usual surveying methods," the statement continued.

The wildcat failure, the farthest seaward to date, was drilled on a 103,680-acre block of leases for which Shell paid the federal Government a bonus of nearly $5,500,000. Continental later acquired half interest in the block.

Drilled in 93 ft. of water in the Gulf of Mexico, the well was bottomed at 13,386 ft. Since then, the same operators have started drilling a second well on the same block of leases about 8 miles northwest of the dry hole *(The Oil and Gas Journal, August 20, page 99)*.

"Mr. Gus," giant seagoing mobile drilling platform owned by C. G. Glasscock Drilling Co., is being used in both deep-water tests.

Producers more costly . . . The companies noted that a producer would have been even more expensive.

Completing the well and installing flow lines, lease tanks, and other equipment would have boosted the well's cost to about $1,500,000, they estimated.

"A significant bit of oil industry economics," the statement added, "is revealed by the fact that if the well had come in as an excellent producer, the state regulatory body would have had to assign it an allowable higher than any on the Gulf Coast if the operators were to recover their investment in any reasonable length of time."

Through 1955, Shell pointed out, oil companies had invested more than $1,250,000,000 in all phases of offshore oil development and were still about $1,000,000,000 in the hole, according to industry estimates.

Gas-Rate Increase Fails

WASHINGTON.—The Federal Power Commission was told last week it should dismiss, rather than deny, independent producers' rate-increase applications that present "new and difficult problems for which precedents are almost wholly lacking."

Dismissal would permit the producers to renew their requests and submit "substantial" evidence of either the inadequacy of existing rates or the propriety of new ones, Examiner Glen R. Law said. This might not be possible if applications are formally denied, he pointed out.

Law made his suggestion in refusing to approve increases from 9.79715 to 17 cents per 1,000 cu. ft. asked by Sun Oil Co., E. J. Hudson, et al.; Maracaibo Oil Exploration Corp.; and Sohio Petroleum Co. on gas from Egan field in Acadia Parish, Louisiana. It was sold to Transcontinental Gas Pipe Line Corp. The examiner held that the producers' evidence did not make it possible to determine either the present fair value of the field's reserves or the present fair value of the gas as a commodity.

Texans Rap FPC

Wise County gas, a 2-year-old bone of contention, again draws notice as producers attack disapproval of contracts

BRIDGEPORT, Tex.—A defiant group of Texas independent oil and gas operators last week publicly reprimanded the Federal Power Commission for keeping one of the nation's biggest uncommitted natural-gas reserves shut in for lack of a market.

Christie, Mitchell & Mitchell, a firm of Houston independents with 103 shut-in gas wells in the Wise County area of North Texas, accused the FPC of failure to approve a "fair and realistic sales contract" for the gas.

To insure widespread attention, the operators invited hundreds of landowners and royalty holders in Wise County and adjoining Jack and Parker counties to hear the dramatic charges.

The appeal for public support came less than a month before the FPC is scheduled to reopen hearings on a sales contract which has been pending in Washington for nearly 2 years. The agency has set new hearings in the case for October 1.

While blasting the FPC for its indecision, Christie, Mitchell & Mitchell also aimed a verbal barrage at Lone Star Gas Co. This firm, said the Houston independents, "opposes the fair price we obtained and wishes to maintain its monopolistic position in this area . . . dictating both price and production. It wants to control your gas."

What's behind it . . . The long-smouldering controversy erupted in October 1954 when Natural Gas Pipeline Co. of America and Oil Drilling, Inc., et al. filed for an FPC permit authorizing sale and interstate transmission of gas from the Wise County area. Oil Drilling, representing a group of independents, was controlled by Christie, Mitchell & Mitchell.

Natural Gas Pipeline proposed to build a 350-mile 20 and 26-in. pipeline from the Texas Panhandle to tap the new North Texas reserves. It would pay producers in the Wise County area about 15 cents per M.c.f. for gas and would pipe it to Fritch, in the Texas Panhandle, for transmission to its vast market in the Chicago area.

Lone Star Gas Co., chief purchaser of gas in the Wise County area, objected to the proposed invasion of its supply area. The going rate for gas had been 11 cents per M.c.f. Lone Star objected on grounds that a boost in the field price would force that company to increase the price it had been paying in North Texas and southern Oklahoma *(The Oil and Gas Journal, August 8, 1955, page 78).*

In opposition to the Natural Gas plan, Lone Star proposed to help its competitor augment its dwindling gas supply for the Chicago market.

Under this proposal, Lone Star would build a 230-mile 26 and 22-in. line from a connection with its system in Cotton County, Oklahoma, to Fritch. There, Lone Star proposed to deliver its competitor up to 100,000,000 cu. ft. of gas per day at a price ranging from about 20.6 cents to 22.5 cents per M.c.f.

This would be far cheaper than the 35.6 cents per M.c.f. which Natural estimated gas would cost delivered to Fritch through its own line.

Lone Star also proposed construction of a second line to further bolster Natural's reserves. This line would extend from the Scurry County, West Texas, area to connect with the first at Clarendon.

Joining Lone Star in opposing the North Texas invasion by Natural Gas Pipeline were Oklahoma Natural Gas Co.; State Fuel Supply Co. of Oklahoma; Consolidated Gas Utilities Corp., Oklahoma City; and Upham Gas Co., distributor in a small area of North Texas.

New contracts pending . . . Johnny Mitchell, president of Christie, Mitchell & Mitchell, reviewed the long proceedings before the FPC last week after inviting landowners and royalty holders to a mass meeting and free barbecue at the Bridgeport fairgrounds.

Except for an examiner's report issued last February, he said, no decision or opinion has been handed down by the federal agency.

The examiner's report favored Natural Gas Pipeline's proposal to construct its own line. But it knocked 4 cents per M.c.f. off the price agreed to in the sales contract. As a result, producers and Lone Star found themselves in a strange alliance against the ruling *(The Oil and Gas Journal, February 13, 1956, page 92).*

A new contract negotiated with Natural Gas Pipeline calls for sale of about 85,000 M.c.f. of gas daily at 13 cents. The contract calls for "the usual periodic increases in price and increases in delivery as reserves are expanded." It also provides for a price adjustment based on B.t.u. content which Christie, Mitchell & Mitchell estimates will amount to an additional 1 cent per M.c.f.

"Several months ago," the land and royalty owners were told, "we voluntarily agreed to lower our price to 13 cents from the 14 cents the pipeline company first agreed to pay. We hope this reduction will help speed up the FPC decision."

The Federal Power Commission recently set October 15 for resumption of hearings in the many-pronged dispute. The hearing date was advanced to October 1 on motion of the producers.

"Largest free reserve" . . . Christie, Mitchell & Mitchell estimate the uncommitted gas reserves in the Wise County area may reach 2.5 trillion cubic feet. It refers to this supply as "probably the largest undedicated gas reserve on the North American continent."

The company estimates its own gas reserves in the area at 750 billion cubic feet. Broken down by sectors, these reserves are estimated at 350 billion cubic feet in the Boonsville area, 200 billion around Cottondale, and 100 billion each in the Paradise and Bridgeport sectors.

In addition, Christie, Mitchell & Mitchell estimate its oil and distillate reserves in the area at 15,000,000 bbl.

To date the company has spent about $9,739,000 in its North Texas exploration program. Of this sum, it has recovered only about $700,000 in production.

It keeps an average of six rigs operating in the area and is now drilling an average of 8 development wells and two exploratory wells a month.

If the FPC application is approved, the company proposes to build a $3,000,000 plant to extract liquids from gas produced in the area. The plant would handle about 105,000,000 cu. ft. of gas daily and recover an estimated 145,000 gal. of liquids.

Shale to Get Refining Tests

GRAND VALLEY, Colo.—American Gilsonite Co.'s $12-million refinery under construction near here will be used to test its ability to refine oil from huge shale beds nearby. The plant was designed primarily to transform the solid hydrocarbon gilsonite into metallurgical coke and high-test gasoline.

Petroleum produced from gilsonite is identical to that derived from oil shale, according to company president Ernest F. Goodner. Should the oil-shale experiment prove successful, raw gilsonite and shale would be mined and treated separately, then processed jointly.

The gilsonite refinery also could be

adapted to processing crude oil from nearby fields, Goodner said. The plant is designed so that after the initial processing of gilsonite, he explained, "it wouldn't know the difference" between natural and manufactured petroleum.

The refinery will go on stream by August 1, 1957.

Imports Showdown

Voluntary cuts predicted; committees gear for action

WASHINGTON.—A cut in oil imports by the few companies which have not gone along with the voluntary program was predicted last week by a high administration official as a last-minute move to avert possible Government control.

The prediction came as committees and subcommittees scurried to bring the imports question to a head. Mobilization Director Arthur S. Flemming is moving to set up a meeting of the Cabinet fuels committee. A House ways and means subcommittee prepared to open hearings on foreign trade policy.

Headed by Rep. Hale Boggs of Louisiana, the subcommittee will bring oil into the legislative picture again. The Democratic-controlled group is out to develop the shortcomings of the Republican administration's trade policies.

It invited those interested in foreign trade to criticize those policies and their effects on domestic industry. A number of oil and coal groups have asked to testify on imports.

Requests to be heard have been made by the Independent Petroleum Association of America, Texas Independent Producers and Royalty Owners Association, National Oil Jobbers Council, National Coal Association, Anthracite Institute, and California Texas Oil Co., Ltd.

The jobbers have announced they will oppose restrictions on oil imports. The others will plead for action to cut back the flow of Middle East crude into this country.

Mobilization Director Flemming is trying to set up a meeting for September 24 between the Cabinet fuels committee and its task force. Object is to review a study of the imports situation just completed by the task force.

Apparently, no written report will be made. Instead, the task force will outline its findings and the Cabinet group will decide whether the present formula is to be retained or rewritten.

If the formula is retained, the committee then must say whether present crude imports from the Middle East are excessive.

SPOIL DIRT is scooped, sifted, and dumped on pipe in ditch as...

New Ditch Padder Makes Bow

FLAGSTAFF, Ariz.—A new ditch-padding machine recently was put into service on an experimental basis by Crutcher-Rolfs-Cummings, Inc., Houston, on an El Paso Natural Gas Co. project near here.

Designed by Jim Cummings, the machine uses a modified Parsons 250 ladder-type trenchliner as a base unit.

The ditch padder works in reverse to a conventional ditching machine by heading straight into the spoil bank beside the trench. Specially designed buckets pick up the spoil and dump it onto a grizzly conveyor. Fine dirt sifts through to a rubber conveyor below and is padded onto the pipe. The upper conveyor then carries the rest of the backfill, rocks and all, and dumps it onto the padded pipe.

Industry BRIEFS

NEW YORK.—The 3,450-ton USNS Alatna, first of two Arctic tankers on order for the Navy's Military Sea Transport Service, was launched recently at Bethlehem Steel Co.'s Staten Island yard. The Alatna and its sister ship, the USNS Chattahoochee, will carry diesel oil, aviation gasoline and motor gasoline on Arctic supply runs.

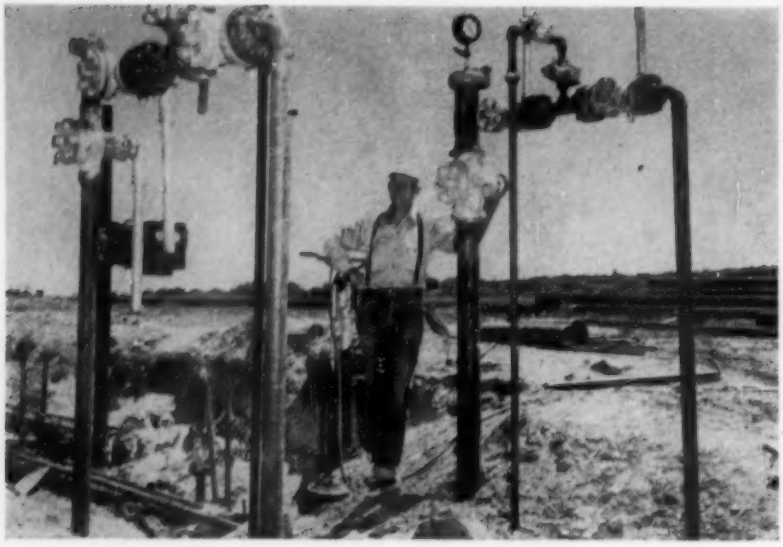
WASHINGTON.—Chairman Walter S. Hallanan has called a meeting of the National Petroleum Council for September 28. Hallanan scheduled the session after a conference with the Secretary of Interior. Reports will be heard from committees on manpower, communications, and emergency-defense organizations.

LOS ANGELES.—Christiana Oil Corp. and Capital Co., a subsidiary of Transamerica Corp., have purchased oil properties of Bartholomas Corp. of Fullerton, Calif. Involved was 900-bbl. daily production from wells in East Cayote field in Orange County and four wells on Signal Hill in the Long Beach field.

VENTURA.—General Petroleum Corp. will buy Santa Paula y Saticoy Oil Co.'s mineral interests in approximately 6,300 acres in Ventura County. The property includes town lots in Saticoy and Santa Paula. Two of the parcels are already producing.

COLLEGE STATION, Tex.—The board of directors of Texas A. & M. College has slated a public auction for September 20 at which it will sell an oil, gas, and sulfur lease on roughly 300 acres of college land in Bee County, South Texas.

DALLAS.—General American Oil Co. of Texas has bought half interest in 550 acres of leases in Garfield oil pool of Pawnee County, Kansas. The company will pay $1,600,000 for the interest to Hilton Drilling Co., E. M. Hilton, of Great Bend, Kans., and others. Of the total, $360,000 will be paid in cash, the remaining $1,240,000 out of 90 per cent of future sales of oil and gas from the property. The 550 acres comprise three leases on which there are 26 oil wells.



After being shut in 28 years . . .

. . . Piceance Gas Gets to Market

PICEANCE CREEK, Colo.—After a $900,000 investment and a 28-year wait, General Petroleum Corp. finally has connected its gas field here in remote western Colorado to the outside world.

The final link was made recently. General Petroleum connected its 48-mile, 10-in. line from the field to the new system of Pacific Northwest Pipeline Co.

The field, located 7,500 ft. above sea level, has 10 producing wells averaging from 3,000 ft. to 3,700 ft. in depth. General Petroleum is operator in the Piceance unit which is composed of 78 leases covering approximately 77,000 acres. Reserve estimate for the unit is 100 billion cubic feet.

The area originally was drilled in 1928 by Magnolia Petroleum Co. in a search for crude. Three noncommercial oil wells were drilled. A realignment of operating territory by the parent company, Socony Mobil Oil Co., Inc., brought the area into General Petroleum's jurisdiction.

By 1947, the company had proved that Piceance was a major gas field, but it lacked two important ingredients —customers and a pipeline. A small pipeline was started but the Korean War caused the company to cancel the project.

Finally, when Pacific Northwest announced plans to build a gas line from the San Juan basin into the Pacific Northwest, General Petroleum resumed work on the connecting lateral August 1955.

Boon for hot-hole drilling . . .

. . . Magnolia Licenses New Mud

DALLAS.—Magnolia Petroleum Co.'s new "secret weapon" surfactant drilling fluids have been made available to the industry via the licensing route.

Socony Mobil Oil Co., Inc., Magnolia's parent firm, has signed a licensing agreement with General Aniline & Film Corp., under which the latter will manufacture essential components of the fluids.

General Aniline's Antara Chemicals Division will sell the products through regular mud-supply companies under the trademarks DMS and DME.

The new fluids are expected to make their biggest contribution by greatly extending the depths to which operators can drill without encountering serious mud troubles from intense down-hole heat.

The first complete account of the new muds appeared in the September 10 issue of The Oil and Gas Journal, page 104.

One of the new class of fluids, a calcium-surfactant type, played a vital role in completing the world's deepest producing oil well last spring. This was the 1-L Humble-L. L. & E. which went to 22,570 ft. in South Louisiana.

The well was drilled by Richardson & Bass, John W. Mecom, and Freeport Sulphur Co. Operator asked for and received Magnolia's permission to use the new fluid to complete the well when the mud being used deteriorated under extreme conditions at that depth.

Earlier, the same mud enabled Magnolia to set a new Texas drilling depth record in West Ranch field on the Gulf Coast. Using the calcium-surfactant fluid, Magnolia drilled several thousand feet of previously undrillable shale and successfully bucked bottom-hole temperatures in excess of 400° F.

Conventional drilling muds solidify quickly at temperatures above 300° F.

Together with its value as a deep-drilling agent, Magnolia feels that use of the surfactant fluids will cut drilling costs in wells with more moderate bottom-hole temperature. Operators, it says, will profit from faster penetration rates and from reduced rig-time due to hole damage and stuck pipe.

The surfactant drilling fluids are a new concept in the formulation of drilling mud. Conventional components such as lime, caustic soda, and organic thinners are eliminated. They are replaced by nonionic surfactants, detergent-like compounds which alter the surface properties of the solid materials in the mud. This permits close control of flow properties under conditions where conventional mud systems fail.

Stanolind, Gulf Split Risk

FORT WORTH.—Stanolind Oil & Gas Co. and Gulf Oil Corp. have made a deal to become joint owners of two big West Texas drilling blocks. The firms bought them individually at a University of Texas lease auction last June for a total cash bonus of $5,550,000.

Gulf paid Stanolind $2,125,000 for a half interest in a 3,840-acre spread in Block 23 in Pecos County. Stanolind last June paid a record bonus of $4,250,000 for this acreage.

In turn, Stanolind has acquired a half interest in 2,735 acres in Block 45 of Crockett County by paying Gulf half of the $1,300,000 the latter paid for this lease in June.

Stanolind will be the operator of the Pecos County, while Gulf will manage operations on the Crockett County.

Stanolind already has staked a 17,000-ft. wildcat, 1-CS University, to test the Ellenburger in Section 27 of the Pecos County block about 10½ miles northwest of the Puckett Ellenburger gas area. Gulf is preparing to spud in a 9,100-ft. Ellenburger test, 1-IB State, in Section 25 of Crockett County.

Are Barinas Bids Due?

There's a hint that Venezuela is so satisfied with its success in the lake it may not grant more concessions

FLUSH with nearly $400 million in cash already offered for choice Lake Maracaibo concessions, Venezuela's President Marcos Perez Jimenez settled back for a bit last week and let the jingle of the busy cash register echo in his ears.

The cash total that American majors and independents are paying for the semiproved underwater lands in Lake Maracaibo has been rising with almost every daily issue of Venezuela's Gaceta Oficial.

By the end of last week most of that acreage—and a lot of outlying lands, too—had been accounted for. *(See table).*

What comes next? . . . A large segment of the world's oil industry, eager for years to get into the Venezuelan play, took one look at the price tags on the lake acreage and very quietly walked away.

Some companies think the cash bonuses, royalty as high as 20 and 25 per cent, and the "special advantages to the nation" demanded by Venezuela were just a bit too much.

It is this group that is waiting hopefully for the word that the country's big and virtually untested Barinas-Apure basin will be the next region to fall under the golden hammer of Jimenez. At least 18 companies are ready to bid. They keep telling themselves land ought to be a little cheaper in this area.

There are two stories making the rounds concerning Barinas.

One, that this region will be opened by October 1, is encouraging to the hopefuls. The other is not so encouraging. It concerns the report that Venezuela is highly satisfied with the outcome of its first offering of concessions in more than 11 years, and that President Jimenez feels the $400 million in bonuses is enough for the present. This is not so comforting.

Only two companies now have production in Barinas, Socony Mobil Oil Co. de Venezuela and Sinclair Oil & Refining Co.

Both have shown a lot of restraint in any publicly expressed evaluation of the region. But, they are spending an estimated $25 million to connect their shut-in fields with the Caribbean by pipeline. First pipe for the 211-mile, 20-in. crude line from Barinas to Puerto Cabello will be laid in December.

Socony and Sinclair make no secret of the fact they would like to have additional acreage in this region. The basin has been the surface exploration hot spot for several years and is generally conceded to be the best candidate for Venezuela's third major producing area.

Others interested . . . In addition to Sinclair and Socony, Amerada Petroleum Corp. (through its 68 per cent holdings in Esperanza Petroleum Corp.) has an interest in scattered blocks in Barinas that total 188,000 acres.

Some of this is right alongside the blocks on which Sinclair and Socony have proved production.

The entire Conorada group (Continental Oil Co., Ohio Oil Co. and Amerada) is interested in Barinas and is expected to be in on the bidding.

Others interested are Creole Petroleum Corp. (Jersey Standard), Mene Grande Oil Co. (Gulf), Cities Service, and other majors as well as independents.

Late Tabulation of Venezuelan Bids*

Company—	Acreage	Location—	Cost
Mene Grande	126,829	Lake Maracaibo	$124,800,000
Mene Grande	98,840	Apure	1,800,000
Shell	59,605	Lake Maracaibo	62,100,000
Shell	49,420	Zulia	900,000
Shell	49,420	Tachira	900,000
Creole	25,441	Lake Maracaibo	23,100,000
Creole	54,362	Apure	900,000
Creole	44,478	Zulia	800,000
Superior	7,774	Lake Maracaibo	20,400,000
Superior	24,710	Apure	450,000
Sun Group	24,710	Lake Maracaibo	17,100,000
Sun Group	24,710	Apure	450,000
Venezuelan Leaseholds	1,969	Lake Maracaibo	3,600,000
Venezuelan Leaseholds	24,710	Apure	450,000
Venezuelan American	26,751	Lake Maracaibo	19,800,000
Venezuelan American	98,840	Zulia	1,800,000
Signal Group	27,608	Lake Maracaibo	31,200,000
Signal Group	74,130	Zulia	1,300,000
Star†	24,710	Lake Maracaibo	18,000,000
Star†	24,710	Zulia or Tachira	450,000
Total	893,727	Total	$330,300,000

*The Venezuelan Government has not officially released winning bids on two Lake Maracaibo concessions. †These figures are subject to revision.

Sicily Has Promising Show

An Italian government company has found a promising oil show in a test about 25 miles northwest of Sicily's Ragusa field.

The show was reported last week in the 1 Gela, being drilled by AGIP, Mineria, S.P.A., a member of the government-controlled E.N.I. group. Fragmentary reports from the well, near Piano Del Signore in the Gela region of Sicily, indicate the company encountered a 105-ft. oil-saturated section slightly above 10,180 ft.

Reds Report Kuibyshev Boom

Russia claims more than 100 new oil wells have been put in production in the Kuibyshev area of the "Second Baku" region during the first 8 months of 1956.

Main center of activity is the Mukhanovo field east of Kuibyshev. There 22 Devonian wells have been brought in this year and total production is more than double the 1955 rate. Output from Kuibyshev province's Chapayevsk and Stavropol fields has also increased. A new Devonian discovery in the Marye-Mikhailovsk area near the Volga River also is reported.

Turks with shovels follow up back hoe . . .

. . . But modern equipment lowers pipe in.

Workers get American-style drinks as . . .

Ancient, New Mingle On Turkish Line

MODERN and ancient construction methods are intermingled as Associated Pipe Line Contractors, Inc., rushes to completion a 425-mile products line to serve air bases in Turkey.

The Houston firm was required to hire mostly native labor for the job. Under provisions of the contract with the Republic of Turkey, only supervisory personnel could be hired in the United States. As a result, Turks in many cases have been trained to drive trucks, help weld, and perform other semiskilled tasks, as pictured above.

The line is being built under sponsorship of the North Atlantic Treaty Organization to transport fuel to its air bases in Turkey (*The Oil and Gas Journal, August 22, 1955, page 107*). Cost of the project is estimated at about $15,000,000.

Starting at the port city of Iskenderun, the line will extend northeast to Batman in the interior. The line will range in diameter from 8 to 4-in. in diameter.

Construction, which started last fall, was hampered for months by a severe winter. The 8-in. portion of the line is now completed, and the 6-in. segment is expected to be finished about October. Remainder of the project should be completed about the end of the year, allowing products to start moving.

Heavy construction equipment, supplies, and skid-mounted housing units for the crew were shipped from Houston.

Photos by Bob Bailey, Houston.

Tanker Record Set

65,000-ton Niarchos ship biggest ever built in U. S.

A NEW record for the largest tanker ordered from a United States shipyard was set last week. The Stavros Niarchos group signed a contract for a 65,000-ton vessel from Bethlehem Steel Co.

The deal for the giant carrier broke the previous record which was held for less than a month by Barracuda Tanker Corp. This firm ordered three 60,000-ton ships from Newport News Shipbuilding & Drydock Co., Newport News, Va. *(The Oil and Gas Journal, September 10, page 101).* The Niarchos ship will be built at Quincy, Mass.

The new record-holder will displace more than 85,000 tons when fully loaded with more than 550,000 bbl. of crude. It will be 850 ft. long with a beam of 115 ft., too wide for the Panama Canal. Service speed of the vessel will be better than 17 knots. Loaded draft will be 42 ft.

Niarchos also ordered a 32,650-ton tanker from Bethlehem's Sparrows Point, Md., yard. His group now has five tankers on order in the U. S. and 23 in foreign yards. Their total weight is 965,000 tons.

The 65,000-tonner and two smaller tankers will sail under U. S. registry. The Maritime Administration approved the transfer of the two other ships being built domestically to foreign flags, a 46,000-ton as well as the 32,650-ton vessel.

Romania to Hear U. S. Claims

Claims of oil companies and other American interests totaling nearly $100,000,000 will be laid before the Romanian Government in October by the State Department.

The department has advised the Red government at Bucharest that it is prepared to talk on this and other questions between the two countries. It suggested that the talks begin October 15, with Robert H. Thayer, minister to Romania, representing the U. S.

The original proposal for talks was advanced by Romania early this year, with claims against Romania, Romanian assets in the U. S. and trade between the two countries as subjects. The department agreed, provided that other problems, including the treatment of U. S. citizens in Romania, were included.

Among the claims outstanding against Romania are those of Socony Mobil Oil Co. and Standard Oil Co. (N. J.) for war damages totaling $30,000,000.

Tests Evaluate Kuwait Strike

KUWAIT OIL CO. is taking a hard look at the subsurface southeast of 1 Raudhatain, a wildcat which late last year established another major field in the Middle East.

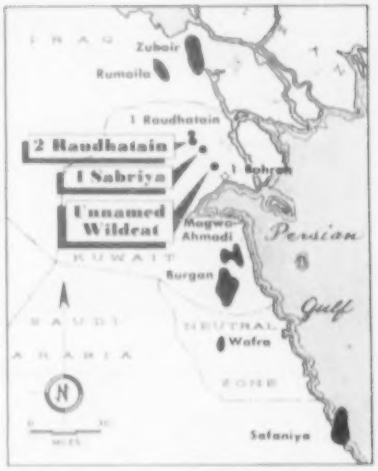
This move to the southeast followed completion of an offset 1.8 miles southeast of the discovery, which is located in the northeast part of the shaikhdom. The 2 Raudhatain was bottomed at 9,695 ft.

The rig used on the offset was then skidded 8 miles east-southeast to a location called the 1 Sabriya. It is now drilling at 1,700 ft. A lighter rig will be moved to 2 Raudhatain later to complete the testing.

Kuwait Oil, owned jointly by Gulf Oil Corp. and British Petroleum Co., Ltd., also has a well drilling about 6 miles northwest of 1 Bahrah, the original dry hole drilled in Kuwait in 1936. The new test, unnamed by the company, is about 10 miles south and a little east of the 1 Sabriya.

A second rig employed in exploration work is in itself a change in the company's program. In the receent past, the company generally has kept four rigs running: One in exploration, two in development, and one divided between work-over and development.

The industry was stirred early this year by reports that the 1 Raudhatain encountered pay sands 1,500 ft. thick and that it might be the most prolific producer in the Middle East. The well has been a "tight hole," but Gulf has officially stated that it unquestionably establishes another major field. It also has reported that a number of oil-bearing zones were found both in formations productive at Burgan field and in deeper pays producing in nearby Iraq fields *(The Oil and Gas Journal, April 2, page 91).*



U. S. vs. Russian oil experts . . .

. . . India Crucial Testing Ground

INDIA is shaping up as a possible proving ground to pit the oil-finding ability of a private American oil company against the operation of a state-owned agency aided by Russian engineers.

Standard Vacuum Oil Co. (Jersey Standard and Socony Mobil) expects to start drilling operations in the Bengal basin of India some time after the first of next year. The company is shipping $850,000 worth of drilling equipment to India to follow up the work of geological and seismic crews in Stanvac's 10,000-sq. mile exploratory area.

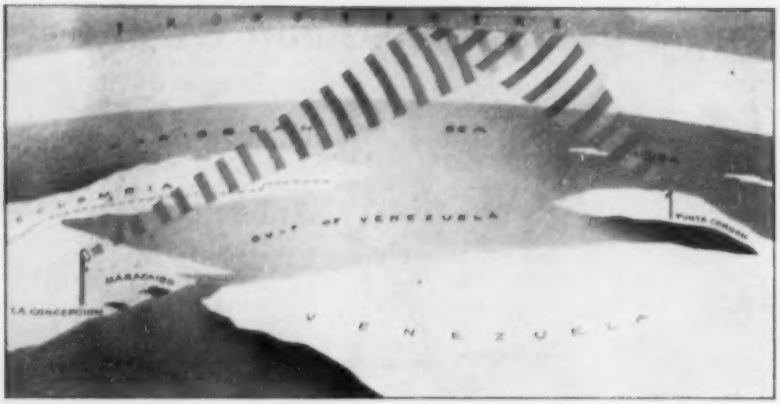
At the same time, India's new government oil and gas commission is gearing itself to find oil on its own. The commission is headed by K. D. Malaviya, Indian Minister of Natural Resources and Scientific Research. Malaviya makes no secret of his socialistic sympathies on any question of private versus government ownership.

His commission's work will be guided by reports of Russian geologists and engineers who are advising India. The Russians have made glowing reports of the country's petroleum prospects. They have singled out five areas in Punjab, a northwestern Indian province, Jaisalmar, and Bengal as regions which should be drilled.

In contrast to the optimistic Russian statements, Stanvac's manager of production for Southeast Asia, T. T. Conger, has been extremely cautious in all his statements for public consumption. He recently told the Indian press he did not think India would be "another Texas or Iraq."

Conger said his company already has spent more than $2,500,000 in its preliminary exploratory work in the basin. He expects his first deep test to cost another $1,500,000 plus cost of the equipment shipped to the country.

Conger made an obvious effort to counteract the idea that Stanvac is certain to find prolific production with its first wells. He told the Indians that the Bengal basin has no large anticlines. He said the geophysical work is concentrated to find stratigraphic traps.



In Venezuela, Shell pioneers

. . . Oil's First Scatter System

THE first communication system in the petroleum industry using tropospheric "scatter" propagation will be installed in Venezuela by Cia. Shell de Venezuela.

The new-type radio system will be placed in operation between La Concepcion and Cardon. It will furnish a direct communication link between production offices at La Concepcion and Shell's refinery at Punta Cardon on the Paraguana Peninsula.

Path length for the one-hop system will be about 125 miles, most of it over water. If conventional microwave were installed instead of the scatter link, nine terminals and repeater stations would be needed.

The equipment . . . Six voice channels will be available initially.

These trunk channels will extend Shell's existing automatic dialing system to include the Cardon refining operation. One voice channel will be used for teletype.

Radio, subcarrier equipment, and installation supervision will be furnished by Collins Radio Co.

The system will use one-kilowatt transmitters operating in the 890-960 megacycle range. Antenna system will consist of two 28-ft. parabolic dishes at each end. These will be on the same elevation but spaced 100 ft. apart horizontally for increased reliability through diversity reception. The dishes will be mounted on 120-ft. oil derricks.

How it works . . . Scatter propagation, as it has come to be called, might more properly be termed transhorizon radio.

Propogation is accomplished by beaming large amounts of power at microwave frequencies into the troposphere where a portion of the energy is "scattered" downward to a receiving station well beyond the line-of-sight distance from the transmitter. Conventional microwave techniques are restricted to essentially a line-of-sight path.

In terms of equipment, principal differences between scatter and conventional microwave which make the long-distance transmission possible are the power of transmitters, the size of antennas and receiver bandwidth. Regular microwave systems ordinarily use less than 1 watt of radio-frequency power and dishes of 6 to 8 ft. in diameter.

Panama Deal Made

Drilling picks up on heels of new Costa Rican strike

CATARACT MINING CORP., New York, has obtained a 2,000,000-acre concession in Panama, most of it lying in Chiriqui Province along the Costa Rica border.

Interest in the area has been magnified overnight by the Union Oil Co. discovery at 2 Cocoles in southeastern Costa Rica, giving Central America its first producer *(The Oil and Gas Journal, September 10, page 96)*. Union is ready to start a test on Panama acreage which adjoins the concession on which the strike was made.

Cataract said it will start drilling in October and is negotiating farmouts with two majors. The firm is working through a wholly owned subsidiary, Cia. Catarata de Petroleo Panama, S.A.

International Oil & Metals Corp., Seattle, is drilling below 1,290 ft. on its first test in the main sedimentary basin of Darien Province adjoining Colombia. The wildcat fulfills a commitment in the agreement by which International Oil acquired 75 per cent interest in a 10,000,000-acre concession from Cia. Petrolera del Golfo del Darien, an affiliate of Commerce Corp. of New York.

International's holdings include more than 200,000 acres in Bocas del Toro Province, some 50 miles from the Panama concession on which Union will drill.

Mexican Output up

Net gain in reserves is set at 127,600,000 bbl.

RISING Mexican production has averaged 265,000 bbl. daily this year.

This figure was given by President Adolfo Ruiz Cortines in his review of the petroleum industry at the opening of congress. He said output was up 10,000 bbl. daily from the 1955 average of 225,000 bbl. daily. Reserves were placed at 2,885,900,000 bbl. as of August 31, a net gain of 127,600,000 bbl. over the same date last year.

The president's production figure probably included condensate since 1955 crude ouput was listed earlier as 244,800 bbl. daily. Crude output the first 3 months of this year has been officially set at 249,300 bbl. daily.

On the transportation side of the industry, projects completed in the last year, or now under construction, included gas gathering lines on Poza Rica field, a 25,000-bbl. daily products line from Minatitlan refinery to Salina Cruz across the Isthmus of Tehauntepec, and a 50-mile, 20,000-bbl. daily crude line from Angostura to Veracruz.

Cuban Wildcat Is Started

A rank wildcat, some 100 miles east of nearest production at Jatibonico field, was spudded last week in Cuba by Cavalier Petroleum Co. of Cuba, jointly owned by Russell Cobb, Jr., Inc., Tulsa, and the Benedum interests of Pittsburgh.

The test, located on a 685,000-acre concession in Oriente Province, is projected to the Cretaceous which is expected to be found between 6,000 and 10,000 ft. C. J. Simpson Drilling Co. has the contract.

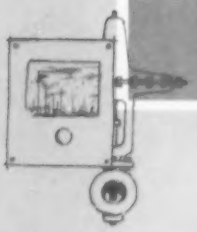
Cavalier owners also hold concessions between the Isle of Pines and the mainland in the Bay of Batabano. Officers of the new company are Paul G. Benedum, chairman of the board; Russell Cobb, Jr., president; Richard L. Hull, first vice president; C. William Campbell, second vice president; and Peter K. Waering, Havana, general manager.

JOURNAL'S ANNUAL
REVIEW OF....

OIL AND GAS JOURNAL

PIPELINE ENGINEERING

LINES AND STATIONS



CONTROLS

OPERATIONS

A JOURNAL TECH-REPORT

Pipelines—Greatest Transport Bargain

by Kenneth B. Barnes
Editor

PIPELINES make available to the American consumer some of the greatest economic bargains in the land—petroleum products and natural gas. Considering the country's network of pipelines as common carriers—as they are when in interstate service—these pipelines are furnishing today's biggest transportation values.

Pipelines offer low-cost transportation, and they are underground, out of sight, noiseless, efficient.

The industry's pipelines guarantee uninterrupted, reliable service to millions of customers, and the flow moves continuously, night and day, winter and summer.

Tariff examples . . . The Oil and Gas Journal, in the tables below and in accompanying maps, has selected pipeline tariffs covering all principal sources to key designation points. These data illustrate the low-cost transportation values contributed by the pipelines. The figures are from the official published tariffs issued under the regulations of the Interstate Commerce Commission. Oil tankers and barges are other forms of economical long-distance petroleum transportation.

Tables and maps . . . The table at left, below, lists pipeline rates and current railroad tank-car charges for transportation of crude oil via important routes, throughout the United States. The rail charges have been calculated on the basis of 7.4 lb. per gallon. The map facing this page shows the principal crude-oil pipeline routes through the United States, and the range of pipeline tariffs therefor.

The table at right, below shows product pipeline tariffs as compared to railroad charges, the latter being computed on gasoline shipments on 6.6-lb. per gallon basis. The map on the reverse side, next page, displays the products pipeline routes and range of tariffs.

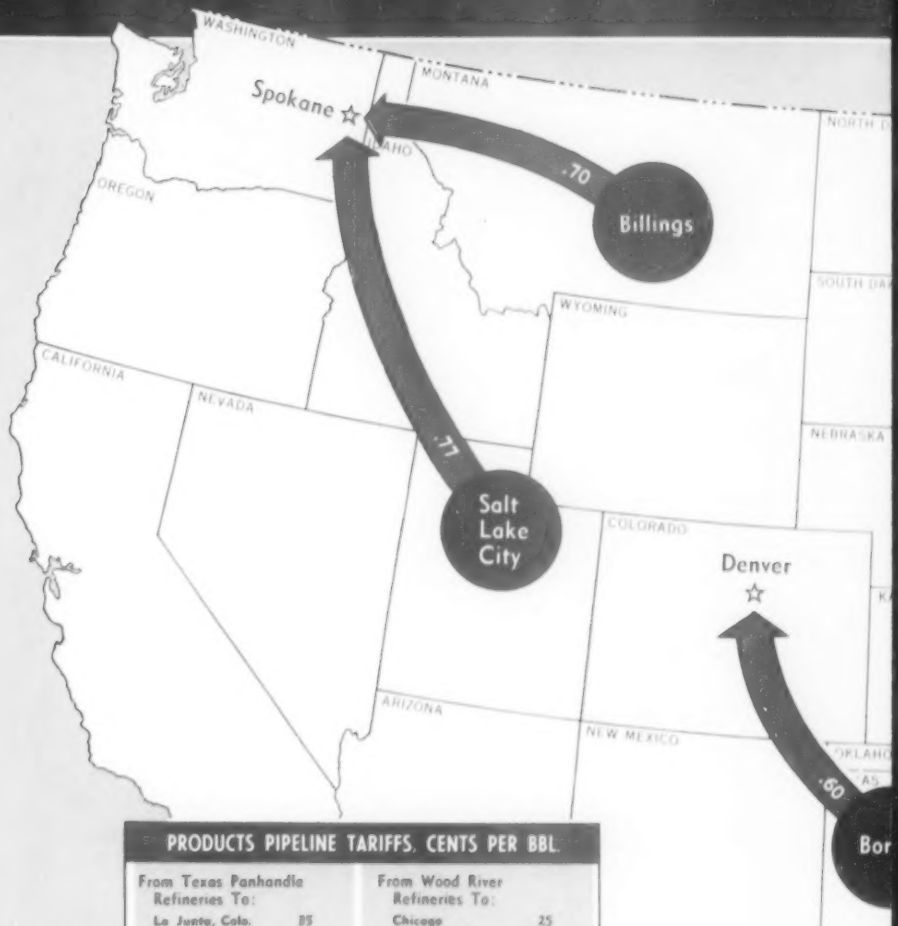
Crude-Oil Pipelines vs. Railroad Charges

	Pipeline rates, cents per bbl.	Railroad dollars per bbl.
FROM MIDLAND, TEX., TO:		
Houston	18-21½	1.75
Chicago	35-40	1.66
Toledo	46-52	2.52
FROM SHREVEPORT TO:		
Baton Rouge	10-15	0.93
Cincinnati	23½-40	2.04
FROM McALLEN, TEX., TO:		
Corpus Christi	5-12½	1.04
FROM HOUSTON (VIA TANKER) TO:		
Philadelphia	37½	3.06
FROM SHAWNEE, OKLA., TO:		
Kansas City	10-21	0.89
Chicago	25-28	1.39
FROM BORGER, TEX., TO:		
Kansas City	23	1.00
FROM GREYBULL, WYO., TO:		
Denver	28-29	2.54
Wood River	36	1.86
Chicago	39	1.43
FROM GUERNSEY, WYO., TO:		
Wood River	32-34	1.21
FROM STERLING, COLO., TO:		
Chicago	35	1.21
Detroit	49	2.71
FROM EDMONTON TO:		
Sarnia, Ont.	64	7.02
St. Paul	44	8.76
FROM MOOSEJAW, SASK., TO:		
St. Paul	77	6.18
Sarnia, Ont.	58	5.75

Products Pipelines vs. Railroad Charges

	Pipeline rates, cents per bbl.	Railroad dollars per bbl.
FROM BORGER, TEX., TO:		
Denver	60	1.56
Kansas City	33	1.12
FROM HOUSTON TO:		
Fort Worth	30	1.06
Dallas	30	0.98
Kansas City	68	1.21
Baton Rouge	12-15	1.15
FROM TULSA TO:		
Kansas City	28-39	0.99
Chicago	58	1.66
FROM BATON ROUGE TO:		
Birmingham	20	0.99
Athens, Ga.	29	2.17
Greensboro, N. C.	40	2.61
FROM KANSAS CITY TO:		
Wood River	32	1.08
Chicago	43	1.43
FROM WOOD RIVER TO:		
Chicago	25	0.96
Indianapolis	23	1.37
FROM CHICAGO TO:		
Detroit	22	1.47
Madison, Wis.	24	0.62
FROM LINDEN, N. J., TO:		
Pittsburgh	32	1.75
Syracuse	35	1.53
FROM PHILADELPHIA TO:		
New York	8	1.05
Syracuse	26-27	1.59
FROM BILLINGS, MONT., TO:		
Helena, Mont.	22	0.85
Spokane	70	1.52
FROM SALT LAKE CITY TO:		
Boise, Idaho	42	1.30
Spokane	77	2.42

PRODUCTS PIPELINE TARIFFS FRC



PRODUCTS PIPELINE TARIFFS, CENTS PER BBL.

From Texas Panhandle Refineries To:

La Junta, Colo.	85
Denver	60
Yale, Okla.	12
Wichita, Kan.	29
Kansas City	33

From Houston Area Refineries To:

Ft. Worth - Dallas	30
Oklahoma	39 - 54
Kansas City	68
Baton Rouge	12 - 15
Arkansas	14 - 20

From Oklahoma Refineries To:

Kansas City	28 - 39
Omaha	37
Memphis	32
Wood River	46
Chicago	58
Minneapolis	58
Fargo, N. D.	75

From Baton Rouge Refineries To:

Birmingham	20
Athens, Ga.	29
Spartanburg, S. C.	34
Greensboro, N. C.	40

From Kansas City Refineries To:

Wood River	32
Chicago	46

From Wood River Refineries To:

Chicago	25
Indianapolis	23
Kansas City	34

From Chicago Refineries To:

Detroit	22
Toledo	22½
Madison, Wis.	24

From Linden, N. J. Refineries To:

Pittsburgh	32
Syracuse	35

From Philadelphia Refineries To:

New York	8
Harrisburg	10
Pittsburgh	20 - 34
Syracuse	26 - 27
Youngstown	29 - 36
Detroit	62

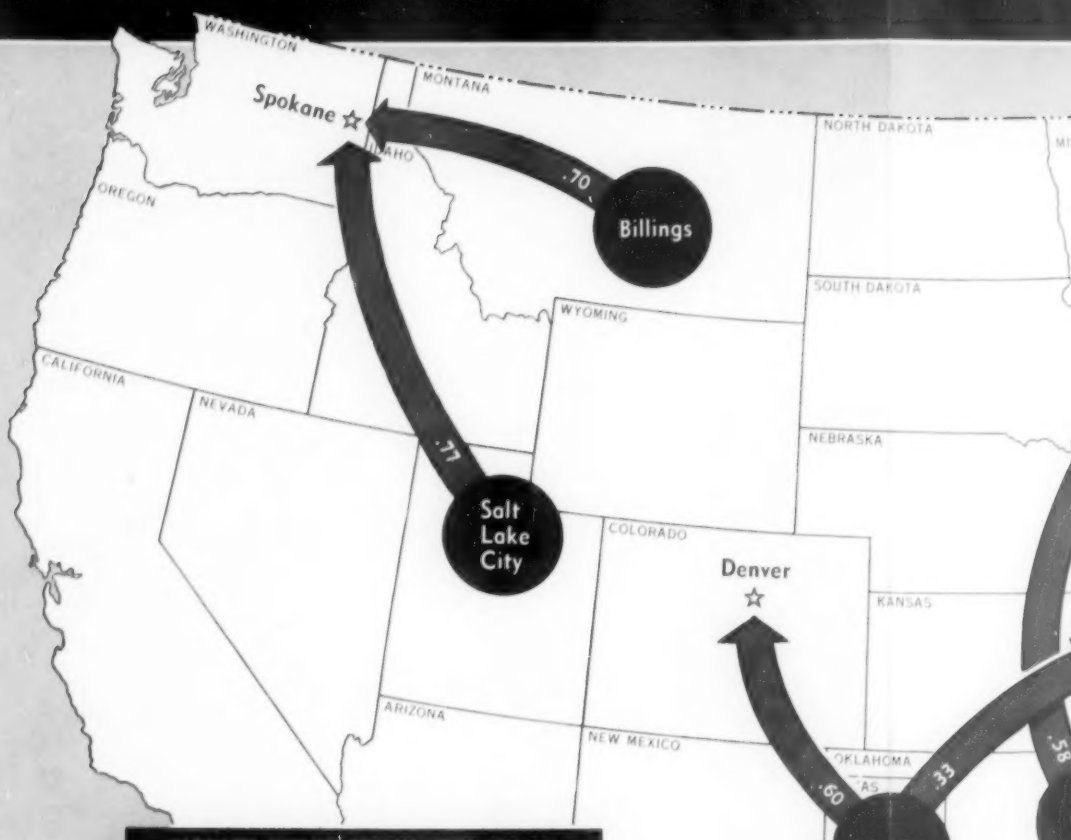
From Billings, Montana Refineries To:

Helena, Mont.	22
Missoula, Mont.	43
Spokane	70

From Salt Lake City Refineries To:

Twin Falls, Idaho	33
Boise, Idaho	49
Baker, Ore.	56
Spokane, Wash.	77

PRODUCTS PIPELINE TARIFFS FROM PRI



PRODUCTS PIPELINE TARIFFS, CENTS PER BBL.

From Texas Panhandle Refineries To:

La Junta, Colo.	35
Denver	60
Yale, Okla.	12
Wichita, Kan.	29
Kansas City	33

From Houston Area Refineries To:

Ft. Worth - Dallas	30
Oklahoma	39 - 54
Kansas City	68
Baton Rouge	12 - 15
Arkansas	14 - 20

From Oklahoma Refineries To:

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Wood River	48
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From Kansas City Refineries To:

Wood River	32
Chicago	46

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Chicago	25
Indianapolis	23
Kansas City	34

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Detroit	22
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Detroit	62

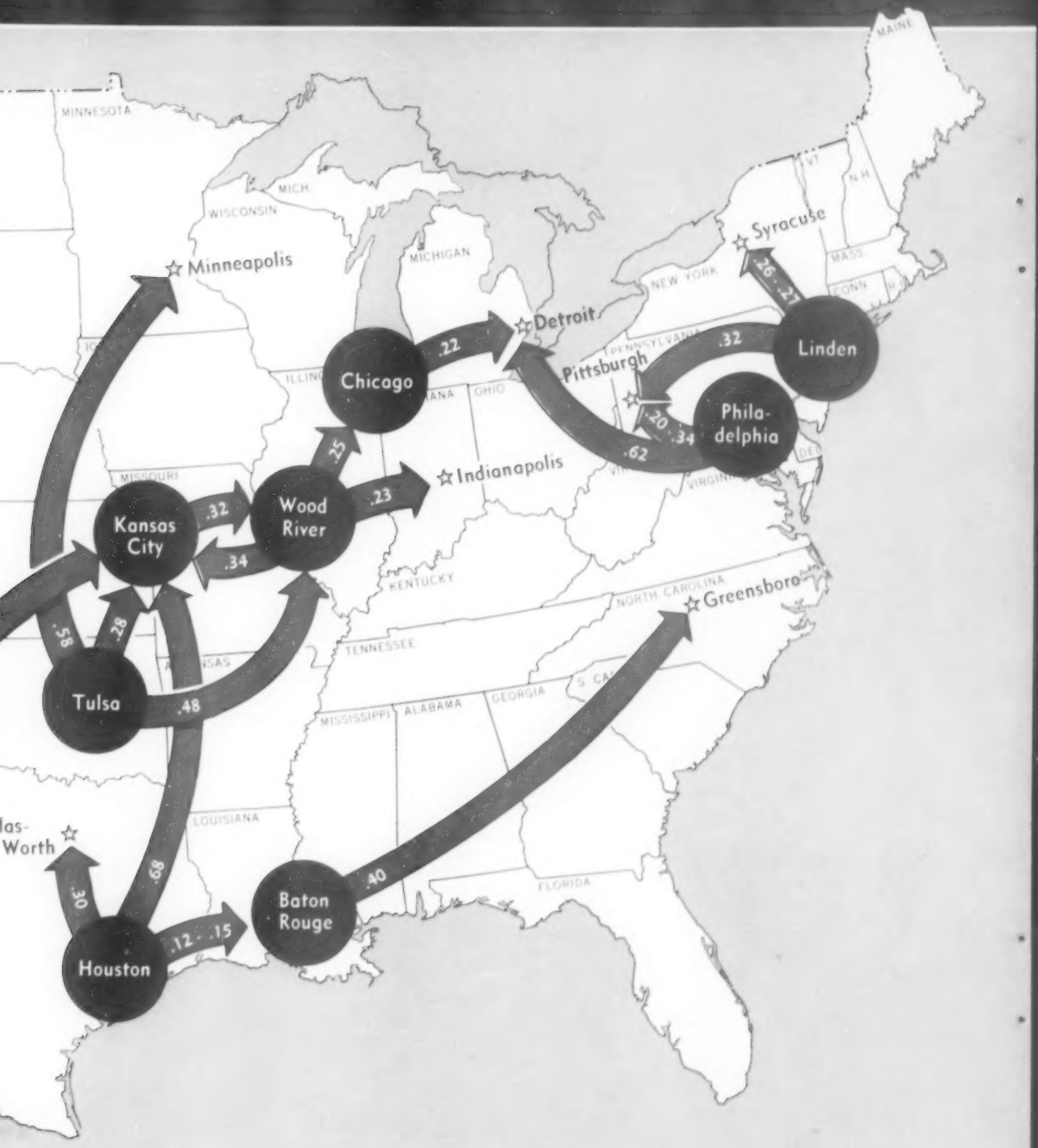
From Billings, Montana Refineries To:

Helena, Mont.	22
Missoula, Mont.	43
Spokane	70

From Salt Lake City Refineries To:

Twin Falls, Idaho	33
Boise, Idaho	49
Baker, Ore.	56
Spokane, Wash.	77

PRINCIPAL REFINERIES TO CONSUMERS



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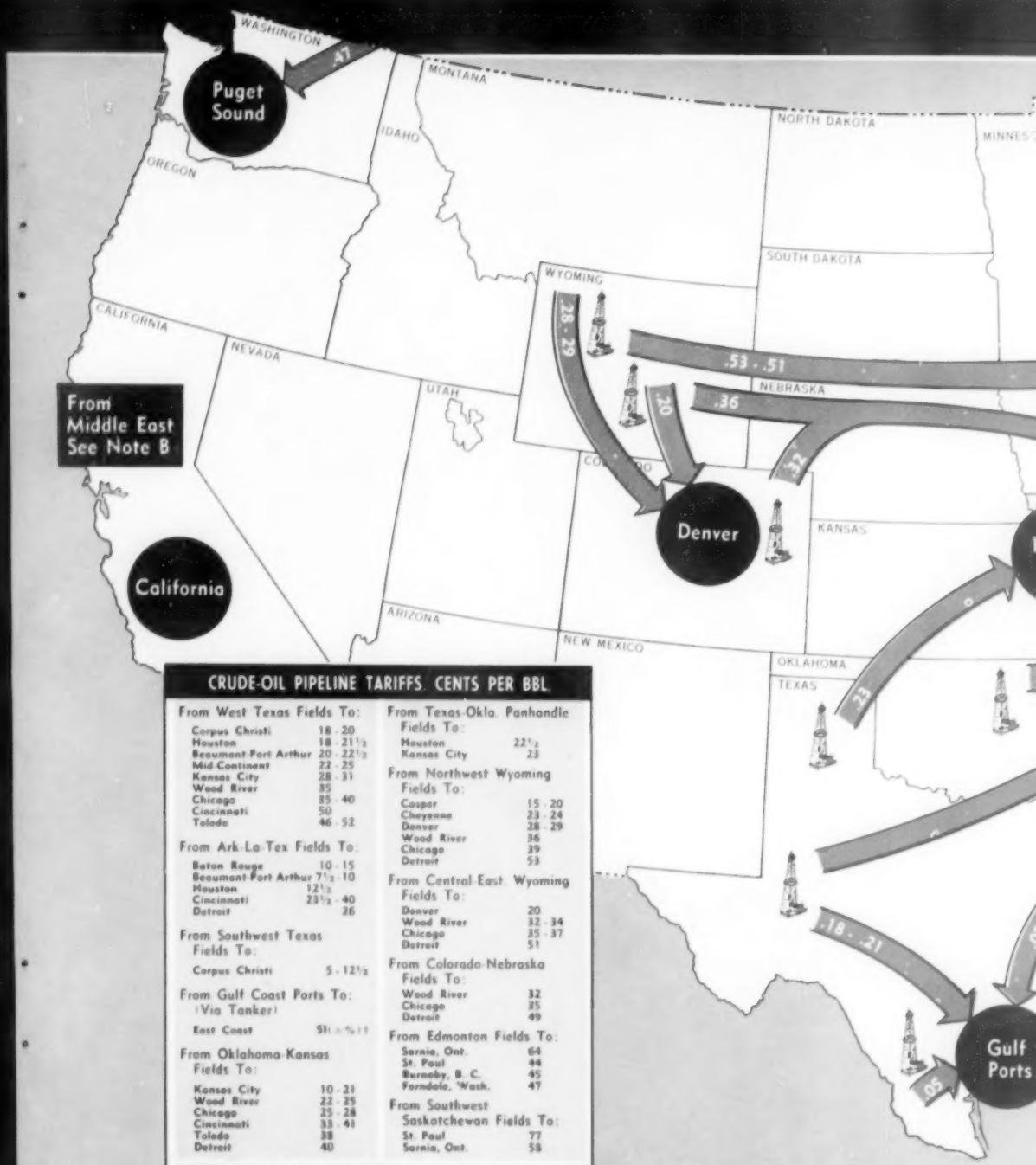
CRUDE-OIL PIPELINE TARIFFS TO



CRUDE-OIL PIPELINE TARIFFS. CENTS PER BBL.

From West Texas Fields To:

Corpus Christi	18 - 20
Houston	18 - 21½
Beaumont-Port Arthur	20 - 22½
Mid-Continent	22 - 25
Kansas City	28 - 31
Wood River	35
Chicago	35 - 40
Cincinnati	50
Toledo	46 - 52

From Ark-La-Tex Fields To:

Baton Rouge	10 - 15
Beaumont-Port Arthur	7½ - 10
Houston	12½
Cincinnati	23½ - 40
Detroit	26

From Southwest Texas Fields To:

Corpus Christi	5 - 12½

From Gulf Coast Ports To: (Via Tanker)

East Coast	$1[illegible]

From Oklahoma-Kansas Fields To:

Kansas City	10 - 21
Wood River	22 - 25
Chicago	25 - 28
Cincinnati	38 - 41
Toledo	38
Detroit	40

From Texas-Okla. Panhandle Fields To:

Houston	22½
Kansas City	23

From Northwest Wyoming Fields To:

Casper	15 - 20
Cheyenne	23 - 24
Denver	28 - 29
Wood River	36
Chicago	39
Detroit	53

From Central-East. Wyoming Fields To:

Denver	20
Wood River	32 - 34
Chicago	35 - 37
Detroit	51

From Colorado-Nebraska Fields To:

Wood River	32
Chicago	35
Detroit	49

From Edmonton Fields To:

Sarnia, Ont.	64
St. Paul	44
Burnaby, B. C.	45
Ferndale, Wash.	47

From Southwest Saskatchewan Fields To:

St. Paul	77
Sarnia, Ont.	58

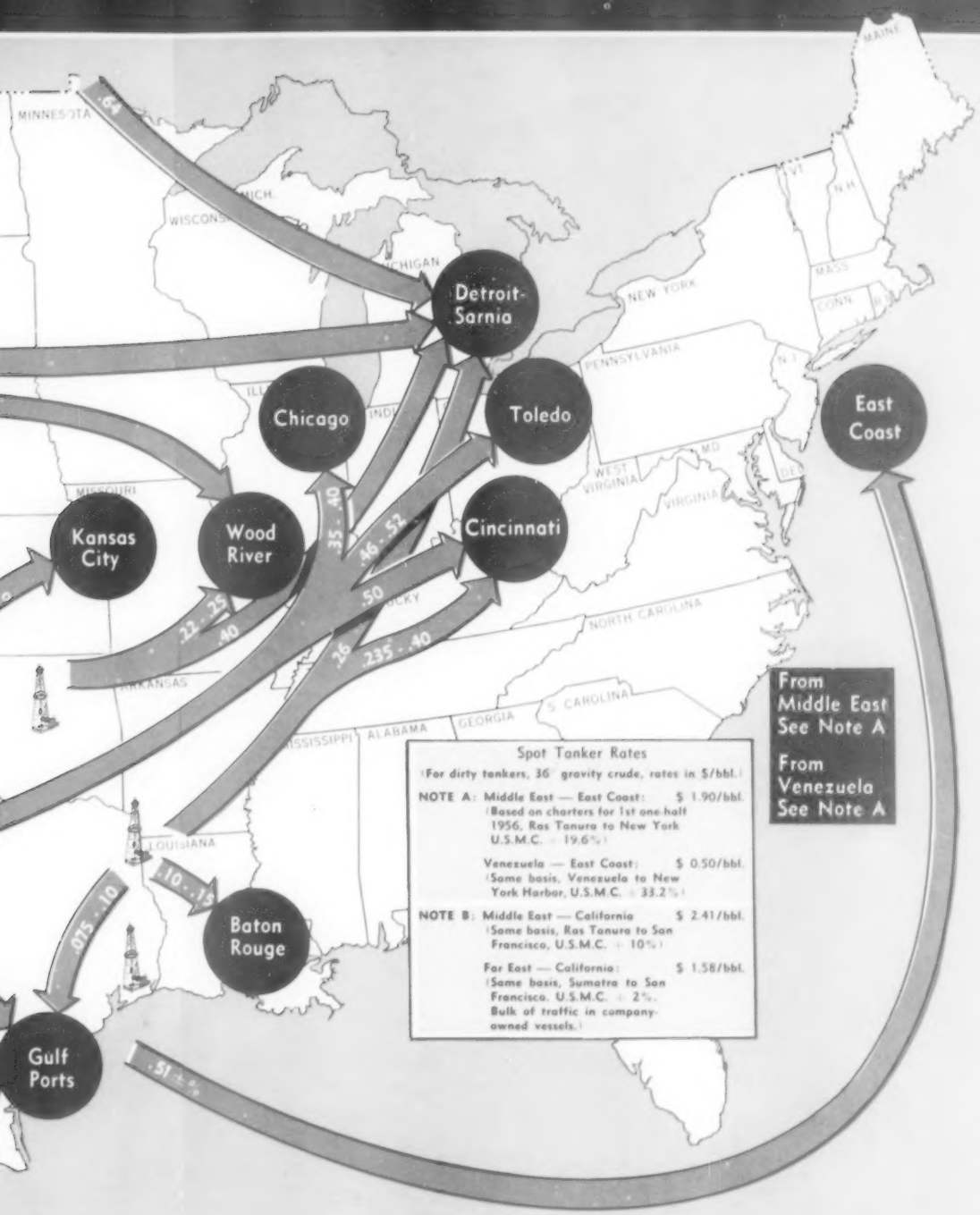
RANGE OF TARIFFS. This covers the small differences in tariffs posted by competing carriers. For example, in moving oil from Southwest Texas to Corpus Christi, the range of 5 to 12½ cents covers oil moved from deep in the valley and also oil moved from points near Corpus Christi.

GATHERING. A gathering charge from 5¢ to 15¢ per bbl. is assessed in addition to the rates shown.

PIPELINE TENDER DEDUCTION. To cover losses incidental to transportation, pipeline companies specify in their tariffs that they will deduct a quantity of oil from each crude shipment to cover this pipeline loss. This deduction varies from 0.5 to 1.0 per cent.

[illegible] Base price for dirty tanker is given. Current price varies from base price from time to time according to demand.

O PRINCIPAL REFINING CENTERS



Spot Tanker Rates

(For dirty tankers, 36° gravity crude, rates in $/bbl.)

NOTE A: Middle East — East Coast: $ 1.90/bbl.
(Based on charters for 1st one-half 1956, Ras Tanura to New York U.S.M.C. + 19.6%)

Venezuela — East Coast: $ 0.50/bbl.
(Same basis, Venezuela to New York Harbor, U.S.M.C. + 33.2%)

NOTE B: Middle East — California $ 2.41/bbl.
(Same basis, Ras Tanura to San Francisco, U.S.M.C. + 10%)

Far East — California: $ 1.58/bbl.
(Same basis, Sumatra to San Francisco, U.S.M.C. + 2%. Bulk of traffic in company-owned vessels.)

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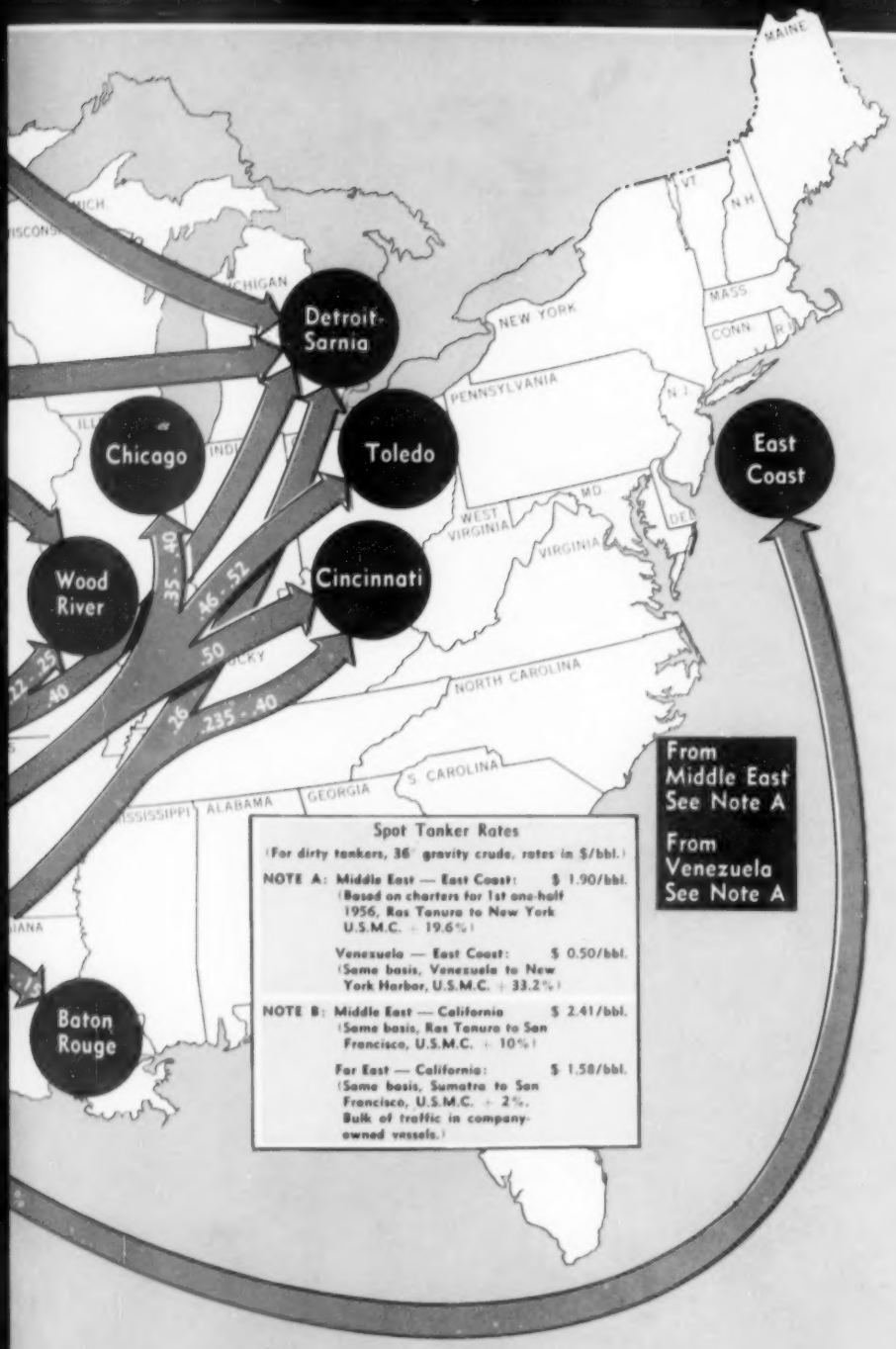

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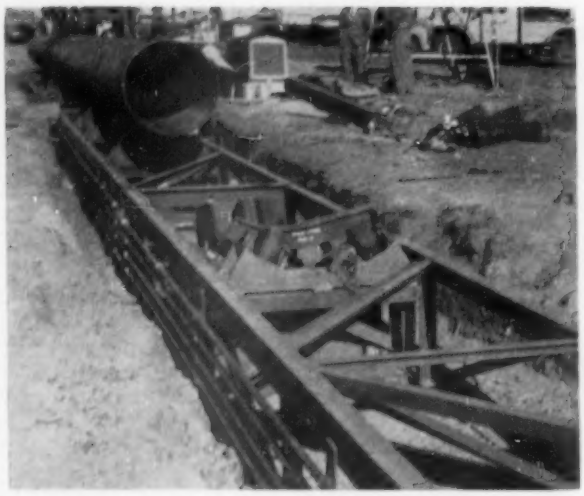
Oil Pipelines . . . Tariff Revenues and Throughputs

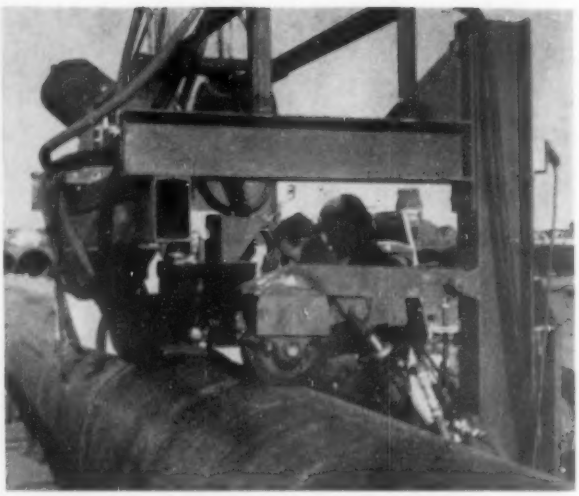
(From the quarterly reports of pipeline companies to the Interstate Commerce Commission)

	Transportation revenues			Throughput		
	Dollars, first 6 mo. 1956	Dollars, total for 1955	Per cent change, 1st half 1956 vs. 1st half 1955	Barrels, first 6 mo. 1956	Barrels, total for 1955	Per cent change, 1st half 1956 vs. 1st half 1955
American Oil Pipe Line Co.	4,174,769	8,854,139	— 6.6	28,879,482	61,332,792	—11.4
Arapahoe Pipe Line Co.	3,691,274	4,201,294	90.3	20,400,736	30,927,533	42.0
Arkansas Pipe Line Corp.	1,016,779	2,166,329	— 7.5	6,446,765	13,165,236	— 2.8
Atlantic Pipe Line Co.§	8,188,209	15,353,752	7.6	61,189,381	121,374,997	1.4
Badger Pipe Line Co.	1,073,569	1,292,744	165.7	7,980,358	9,552,730	167.8
Bradford Transit Co.	382,708	700,081	8.2	2,567,955	4,715,485	7.0
Buckeye Pipe Line Co.	9,268,684	16,644,583	14.5	113,668,897	206,228,100	14.6
Butte Pipe Line Co.†	1,414,409	225,567		5,104,254	1,336,792	
Cherokee Pipe Line Co.	9,321,262	5,351,784	238.8	19,634,360	33,195,477	24.8
Cities Service Pipe Line Co.	3,918,751	7,091,032	20.0	44,692,905	85,455,986	8.7
Continental Pipe Line Co.	3,465,293	6,859,563	1.2	40,819,574	76,733,642	9.2
Cooperative Refinery Association	588,817	1,118,185	7.5	5,151,279	9,801,074	6.0
Crown-Rancho Pipe Line Corp.	360,291	772,518	— 4.4	2,301,967	4,556,015	6.4
Eureka Pipe Line Co.	623,284	1,138,394	8.5	1,487,655	2,721,694	3.1
Freedom-Valvoline Oil Co.	467,781	517,111	134.0	4,660,268	6,332,473	78.5
General American Pipe Line Co.	188,834	364,819	1.1	3,462,117	6,460,494	4.4
Great Lakes Pipe Line Co.¶	19,148,288	36,520,233	5.0	44,158,744	82,725,199	7.5
Gulf Refining Co.	19,030,367	35,547,838	10.1	166,004,357	304,804,846	9.7
Humble Pipe Line Co.	19,134,813	36,525,221	5.2	136,339,584	261,790,404	3.8
Illinois Pipe Line Co.	371,629	770,742	— 5.9	4,910,735	10,130,996	— 5.9
Interstate Oil Pipe Line Co.	10,455,150	19,583,831	11.4	84,142,588	154,546,331	13.5
Kaneb Pipe Line Co.¶	848,550	1,162,343	66.2	6,857,396	9,129,866	76.1
Kaw Pipe Line Co.	1,433,690	2,799,067	4.1	21,735,091	43,238,960	3.2
Lakehead Pipe Line Co., Inc.	7,334,196	13,361,626	21.7	29,218,001	46,395,093	48.6
Magnolia Pipe Line Co.	19,577,197	36,879,764	8.7	91,232,801	173,145,542	6.0
Michigan-Ohio Pipeline Corp.	642,560	1,022,894	33.4	7,695,723	14,306,834	10.8
Mid-Valley Pipe Line Co.	7,669,868	13,920,892	11.7	34,624,849	61,568,098	15.3
Minnesota Pipe Line Co.‡	787,459	373,111		4,981,603	1,553,998	
Nantucket Pipe Line Co.	349,273	611,505	12.9	2,157,388	3,862,624	7.7
National Transit Co.	859,779	1,826,919	— 5.9	7,821,785	14,256,651	13.7
New York Transit Co., Inc.	355,434	696,711	8.0	9,608,213	19,192,332	5.1
Northern Pipe Line Co.	379,290	740,823	8.6	10,269,339	20,483,587	5.0
Ohio Oil Co., Pipeline Department	7,906,676	15,161,096	10.0	103,290,629	179,990,122	19.7
Okan Pipe Line Co.†	317,188	219,265		715,996	587,002	
Okla., Miss. River Products Line., Inc.	2,535,105	3,513,704	52.8	9,519,919	15,345,970	21.7
Phillips Petroleum Co.¶	1,005,494	1,883,213	8.0	2,207,782	3,500,732	36.9
Phillips Pipe Line Co.	15,651,223	28,839,751	11.4	69,358,636	127,354,284	11.8
Pioneer Pipe Line Co.	684,299	1,269,791	9.9	1,664,196	3,078,256	9.9
Plantation Pipe Line Co.¶	12,954,324	26,232,478	2.5	44,752,294	85,226,482	11.0
Platte Pipe Line Co.	6,219,971	11,493,832	11.3	30,009,948	52,214,402	24.2
Portland Pipe Line Corp.	3,012,605	5,414,539	15.4	37,851,964	68,326,971	14.1
Project Five Pipe Line Corp.¶	554,382	1,106,919	0.8	7,059,332	14,542,420	— 0.5
Pure Transportation Co.	3,253,289	5,607,265	24.2	43,147,045	79,052,206	15.4
Salt Lake Pipe Line Co.	5,529,024	9,618,223	14.6	19,499,894	32,155,831	25.8
Service Pipe Line Co.	29,785,297	56,175,141	5.0	96,007,389	177,687,263	5.8
Shamrock Oil & Gas Corp.¶	395,446	807,317	1.2	814,782	1,652,765	— 0.2
Shell Pipe Line Corp.	16,247,496	32,227,981	0.9	80,875,999	151,240,925	8.2
Sinclair Pipe Line Co.	22,010,135	44,233,098	1.6	117,904,197	235,416,757	2.6
Socony Mobil Oil Co., Inc.	336,644	688,264	— 3.1	7,026,059	14,613,232	— 5.5
Sohio Pipe Line Co.¶	3,406,539	6,260,181	12.7	32,972,893	63,222,202	6.9
Southeastern Pipe Line Co.¶	1,410,092	2,865,497	— 0.2	6,149,565	12,812,605	— 1.9
Southern Pacific Pipe Lines, Inc.*	2,367,602			4,080,970		
Sun Pipe Line Co.	7,079,727	13,747,751	3.7	50,140,812	102,133,485	— 3.2
Texaco-Cities Service Pipe Line Co.	4,702,162	10,058,863	—12.5	39,996,508	85,645,561	— 4.6
Texas Eastern Trans. Corp. Prod. Div.†	1,531,694	2,973,694		11,114,099	21,845,855	
Texas-New Mexico Pipe Line Co.	5,524,340	9,768,397	12.2	56,443,592	105,656,757	8.5
Texas Pipe Line Co.	19,064,402	35,061,034	14.5	130,010,206	245,494,965	9.0
Tidal Pipe Line Co.	326,230	670,731	— 9.5	5,982,885	11,686,089	— 1.4
Tide-Water Pipe Co., Ltd.	26,185	118,809	—56.8			
Toronto Pipe Line Co.	984,748	2,019,111	— 0.1	12,614,247	26,425,626	— 2.6
Tuscarora Pipe Line Co., Ltd.¶	863,811	1,733,679	5.0	4,496,472	8,856,404	6.4
Utah Oil Refining Co.	1,668,346	3,075,005	9.7	11,754,113	20,779,369	14.2
West Texas Gulf Pipe Line Co.	4,127,439	7,207,852	14.7	66,635,297	118,243,185	12.4
Wolverine Pipe Line Co.¶	1,476,041	2,978,884	— 1.2	7,378,040	14,191,038	2.9
Wyco Pipe Line Co.¶	1,031,275	2,023,299	11.1	3,170,892	6,193,073	11.8
Wyoming-Nebraska Pipe Line Co.	307,734	586,080	9.6	1,078,613	2,001,271	18.7
Yellowstone Pipe Line Co.	1,078,750	2,059,639	19.0	2,703,768	4,865,958	25.0
Total	341,457,932	622,691,798	12.8	2,148,635,183	3,987,060,944	10.8

*Commenced filing as of first quarter 1956. †Commenced filing as of fourth quarter 1955. ‡Commenced filing as of second quarter 1955. §Merger made up of Atlantic Pipe Line Co., Buffalo Pipe Line Corp., and Keystone Pipe Line Co. ¶Company engaged primarily in handling refined petroleum.



TO PROVIDE rigid support for submerged-arc welding for double jointing, Canadian Bechtel, Ltd., has a steel frame foundation of internal truss construction holding conveyor and rotating equipment.



UNIT running two heads of submerged-arc welding after the stringer head and hot pass had been run manually on other racks.

Trans-Canada Line Steaming Ahead

Two spreads are in field, with one contractor stringing pipe for both

by Paul Reed
Pipeline Editor

IN western Saskatchewan two spreads are laying 34-in. pipe at a fast rate for the start of the Trans-Canada Pipe Lines, Ltd., system. This entire system will extend 2,250 miles from Alberta to Montreal. Two spreads began working in July on the 574-mile, 34-in. section from the Alberta - Saskatchewan border to Winnipeg. Original plans for seven spreads on this section have been interrupted by delays from the steel strike, which meant that only 125 miles of pipe was available at the beginning of the project (*The Oil and Gas Journal, August 13, page 78, and August 20, page 104*).

The two contractors — Canadian Bechtel, Ltd., and Majestic Contractors, Ltd.—each put a spread in the field with equipment that is new this year. Canadian-Parkhill Pipe Stringing, Ltd., strings pipe for both spreads. Together the two spreads laid in the ditch a total of 72 miles through August 23.

The present construction area extends westward from a point near Burstall, Sask., which is 1.2 miles east of Alberta-Saskatchewan border, to the vicinity of Morse, Sask. The Trans-Canada construction office is at Swift Current, Sask.

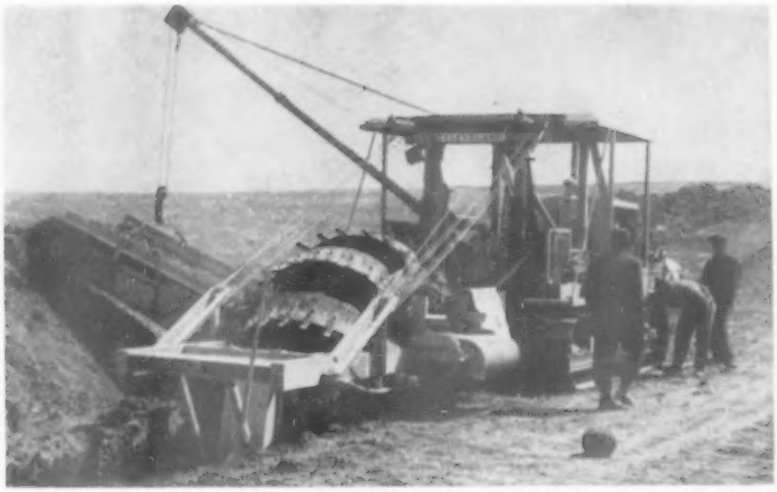
Conditions and methods of construction characteristics of the pipe laying for both spreads are summarized as follows:

Terrain in Section 1 (laid by Majestic) starting near the Alberta-Saskatchewan border generally consists of rolling hills with grazing and cultivated ground. There are numerous lakes and ponds, all of which are avoided, and few streams.

Farther east in Section 2, contracted by Canadian Bechtel, the land continues to be rolling with some slightly

CLOSEUP of twin-arc submerged-arc unit. Granular flux is recovered by vacuum pickup.

FOUR stringer-bead welders work together in the pipe gang of the Majestic Contractors, Ltd., spread.



DITCHER of the type used by both contractors on the Trans-Canada project for the ditch which is 52 in. wide at the bottom and deep enough for 30-in. cover.

choppy hills, and some swampy areas requiring weighting. Thence flat land extends to gently rolling country.

The construction season in Saskatchewan is estimated to be about 3 months. The days were comfortably cool even at noon when the author was at the project in July and August.

The main difference between the basic plans of the two contractors is that Canadian Bechtel is double-jointing with submerged-arc welding at a yard to furnish its spread with 80-ft. joints while Majestic is adding 40-ft. joints to the line.

The pipe is all 34 in. in diameter with ⅜-in. wall except for the ½-in.-wall pipe for a mile on the downstream side of future compressor-station sites. Pipe ends have a 30° bevel.

Pipe arrived at the project covered with a mill primer to protect against rusting while in storage. This primer is removed from the beveled pipe ends either by sandblasting or by power brush to give a clean surface to prepare for welding. To prepare for coating, the broad surface of the pipe is cleaned by cleaning machine in the usual way prior to application of primer.

Following are the principal features of construction:

Right-of-way is 65 ft. wide.

Ditch is 52 in. wide at the bottom which is flat. Top of the ditch is 8 ft. 4 in. wide in sand-hill country and up to 7½ ft. wide elsewhere. Cover is 30 in.

Each spread has two ditchers which operate on a "leap-frogging" schedule by which each digs a trench to full depth. When the rear ditcher reaches the ditch ahead, it passes around the front ditcher to start digging again farther out on the right-of-way.

Line-up for welding in the pipe gangs is facilitated by the recently developed pneumatic clamps. "High-lows" were quickly ironed out so that line-up is commonly completed in 30 seconds.

Interruptions to pipe-gang progress are avoided by having two pneumatic clamps. Numerous adjustments are made periodically during the day as a matter of routine. The clamp is charged with compressed air through a hose from air supply on truck or trailer carrying welding machines. This charging is done after every five or more welds to bring pressure up to 150 psi. after it has dropped to about 125 psi.

These air-operated line-up clamps are important factors in the fast progress of pipe gangs of both spreads.

Joints are regularly added at the rate of one every 2 to 3 minutes by running stringer beads with three or four welders.

Each spread has between 30 and 32 welders. Radiographic inspection is applied to 10 per cent of the welds.

In fairly level country the pipe is welded in sections of 4,000 ft. and more. There are few roads to cross. Therefore the tie-in welds are at long intervals.

Tie-in welding is done in the morning. To complete a weld on 34-in. pipe takes about an hour.

Pipe protection is provided by coal-tar enamel, wrapped with a glass mat referred to as "inner glass" which is not imbedded in the enamel. Outer wrap is kraft paper.

Cradling of the pipe into the ditch is done immediately behind the doping operations.

Double slack loops are put in the pipe at 1,000 to 1,500-ft. intervals in fairly flat country to protect against damage from contraction in cold weather.

To form each slack loop the pipe is supported by crotched skids at two points 30 ft. apart, at the 1,000 to 1,500-ft. intervals.

Backfilling proceeds as close as 600 to 1,000 ft. behind the dope gang because of the practice of cradling into the ditch. As a result the contractors get the advantage of economies from shortening the length of the spread operations as a whole as well as by the elimination of a separate lowering-in gang far back at the rear end.

While American personnel perform an important part in supervision and

MAP showing how Trans-Canada Pipe Lines, Ltd., plans to transmit gas from Alberta Gas Trunk Line, Ltd., system to Montreal. Initial gas will come from Bindloss field. Pipe is now being laid between Burstall and Morse, Sask., on the leg to Winnipeg.

PNEUMATIC line-up clamp removed at the pipe gang to make adjustments. The spreads of both contractors use this type of unit which lines up pipe quickly.

R. L. (DICK) LEONARD, spread superintendent, Majestic Contractors, Ltd., standing in front of the company's ambulance which is constantly in attendance on the spread.

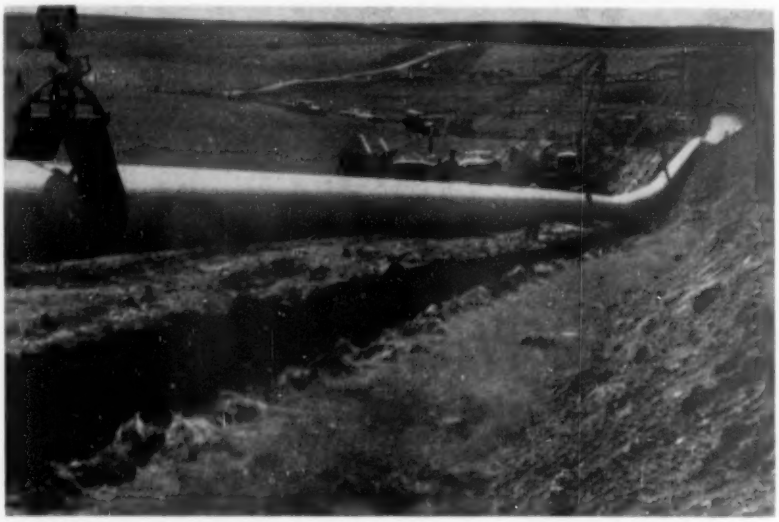
key jobs, Canadians are employed extensively for skilled work of operators and welders. Common labor is entirely Canadian. Each spread employs a maximum of approximately 250 men.

This construction project is supervised by a staff loaned by Tennessee Gas Transmission Co. to Trans-Canada Pipe Lines, Ltd., including C. S. Coates, executive vice president and general manager; Joseph Parrish, acting chief engineer; Kenneth E. Britain, division project engineer; and Carl C. Whitaker, construction superintendent.

The Majestic spread is manned largely by personnel which have been engaged for some time in Canadian pipeline construction. A number of the supervisors for the Canadian Bechtel spread were engaged last year on the Tennessee Gas Transmission Co. project in the White Plains, N. Y., area. Several of the supervisors for Trans-Canada from the T.G.T. organization were connected with the T.G.T.'s "Muskrat" project this spring in marshes and offshore areas of Louisiana. It is hard to imagine greater contrasts than those between the work where the author previously contacted the men on these projects in the congested metropolitan area of White Plains, on the outskirts of New York City, and in the hot, watery world of the Mississippi Delta of Louisiana on one hand as compared with the lonely, cool northland prairies of Saskatchewan on the other hand.

This Saskatchewan region still has a pioneering atmosphere even though it was being homesteaded only about 50 years ago.

On the Alberta-Winnipeg project of Trans-Canada Pipe Lines, Ltd., the Canadian Bechtel, Ltd., spread was the first in the field. Between July 12 and August 23, a total of 39 miles was laid and backfilled.



CRADLING into the ditch directly behind the coating and wrapping machine. The ditch is being backfilled 600 ft. behind dope operations.

The outstanding feature of the Canadian Bechtel operations is a specially designed double-jointing yard installed near Morse, Sask., for joining 40-ft. joints to make 80-ft. joints.

The chief advantage of the double-jointing yard appears to come through increasing the output of the spread on the right-of-way. For with the longer joints the spread moves ahead 80 ft. instead of 40 ft. each time a joint is added to the line at the pipe gang.

The yard operates for a scheduled output of 125 joints per day of 80-ft. lenth (total of 9,000 ft. daily). This rate of progress was more than matched at the spread in the field by welding 9,500 ft. on August 5, the first day that the 80-ft. joints from the yard became available on the right-of-way.

Welding of the last two beads is done by submerged-arc welding preceded by manual stringer bead and hot-pass welding.

Three 80-ft. 34-in. joints (240 ft.) are carried on a stringing truck. This represents a gain of 40 ft. of pipe per load because in hauling 40-ft. pipe the load is five joints (200 ft.).

A notable feature of this yard is the provision for rigidity of the racks on which all three welding operations are performed—stringer bead, hot pass, and submerged arc. These racks are rectangular steel box frames fabricated with internal truss construction.

Racks for the stringer bead welding and hot pass rest on the surface of the ground. The foundation rack for submerged-arc-welding operations rests in a trench dug so that the top of the rack is on a level with the surface of the ground.

The working day at the yard was 12 hours when the author visited it

Trans-Canada Pipe Lines, Ltd., engineers on the project near Burstall, Sask.: W. M. Smith, engineer; Kenneth E. Britain, division project engineer; and Joseph Parrish, acting chief engineer.

Robert Mitchell, project manager, Majestic Contractors, Ltd.; and Elva Pauley, spread inspector, Trans-Canada Pipe Lines, Ltd.

Engineers, inspectors, supervisors

Joe Work, superintendent, Canadian Bechtel, Ltd.; Carl C. Whitaker, construction superintendent; and C. H. Cunningham, inspector; both of Trans-Canada Pipe Lines, Ltd.

late in July. Since then, automatic welding operations have sometimes run 24 hours while the stringer-bead and hot-pass work was done in a single daylight shift. All operations for the submerged-arc welding — including injecting the joint, running two beads and ejecting the joint would average 11½ minutes per joint per 24-hour day.

The first step at the yard is removal of priming coat by sandblast from the bevels and ends of the pipe. The priming coat was applied to protect while in storage prior to shipment to the project.

In July there were four manual electric-arc welders — two for stringer beads were run on the first rack from which the pipe was rolled to another rack for running the hot pass.

Pipe is rolled along the storage racks to the conveyor feeding into the semi-automatic welding unit.

Endo rollers, rotated by compressed air, move the 80-ft. joint rapidly into position for the running of the filler and cap bead by submerged-arc welding.

Submerged-arc welding is done by a Lincoln weld unit with twin arcs served by two tandem wires on a line with the joint seam. The operator has controls for regulating rotation speed, current, voltage and the flow of flux.

The pipe is rotated by a variable-speed electric motor. Movement of the pipe on the conveyor is handled by pneumatic power which the operator regulates by controls for near endo, far endo, injectors, rack stops, center lift, hold down, end lifts and safety latch.

The submerged arc welding unit is served by two engine-driven 600-amp. generators. Compressed air is furnished by a 600-cu.-ft. compressor delivering 100 psi.

Granular flux is conserved by wind shields and by a vacuum pickup which make it possible to recover about 80 per cent of the flux.

Before the long 80-ft. joints reached the pipe gang, 40-ft. joints were strung on the right-of-way. Therefore the benefit of the long joints did not come until they began to be added to the line on August 5. Shortly before that time the spread had been laying about 1 mile per day. Stringer beads in the pipe gang are run by three welders working simultaneously.

Canadian Bechtel, Ltd., operations on the Trans-Canada project are managed by Robert Bowman and supervised by Joseph Work.

Majestic Constructors, Ltd., moved its spread at the end of July from a recently completed project of Interprovincial Pipe Line Co. in Manitoba. The pipe gang started July 28. The whole spread was in full swing on August 1. On August 5 it welded 200 joints of 40-ft. pipe (total of 8,000 ft.). Up to the end of August 23, it had 33 miles in the ditch.

A feature of Majestic's operations is the use of four stringer-bead welders working simultaneously in the pipe gang. When the author was at the spread, three of the stringer bead welders were right-handed and one was left-handed. At least one left-handed welder is desirable for such a team welding close together on 34-in. pipe.

Buffing of the bevels to remove primer and to clean in preparation for running stringer beads is done by a pneumatic operated buffer running at 3,600 r.p.m. which was found to give less trouble than electric grinders for the same purpose.

A fully equipped ambulance manned by a third-year medical student stays with the spread continually. Majestic has an airplane with a cabin suitable for transporting ambulance cases to a hospital. Both ambulance and plane have two-way radios. They are available for people in nearby communities as well as for men in the spread in emergencies.

When the spread moved 600 miles from the Interprovincial 80-mile, 24-in. project between Gretna and Souris, Man., the family trailers of the Majestic employes were transported in 2 days to the contractor's trailer camp at Leader, Sask. On arrival all connections were ready at the camp for water, electric power, and sewer. Shower facilities were set up and ready for use.

Robert Mitchell is project manager and R. L. (Dick) Leonard is superintendent of the Majestic spread.

RAINS LEFT TERRAIN in this condition for many miles in Ohio's hill country but . . .

NEW EQUIPMENT like these twin diesel-driven welding machines helped pipe gangs keep footage high.

Wet Work on T.G.T. Loops

It rained, and it rained. Then rained some more. But good footage rates were made in spite of it.

by R. G. Deering
Assistant Pipeline Editor

CONSTRUCTION this summer of loop lines in Ohio for Tennessee Gas Transmission Co. show how modern pipelining techniques and equipment can overcome some pretty tough obstacles.

Despite the wettest July in many years—wettest in history in some parts of Ohio—two spreads which the author visited were making progress averaging about 3,500 ft. per day. Of course many days are included in the average in which no work was done.

Contrasting methods of construction were seen on the two spreads visited. H. C. Price Co. has one section and is using a central double-jointing yard. Oklahoma Pipe Line Constructors uses single 40-ft. joints. Oklahoma was cradling directly into the ditch behind the coating machine while Price was using a separate lowering-in crew.

Top footage amounted to 9,000 ft. for the spread using the double joints and welding 60-ft. pipe on the right-of-way. On the other spread the newest in tractor-mounted welding equipment helped keep the pipe gang's footage high on days when work could be done. On both spreads the abundance of heavy tractor equipment often meant the difference between having trouble with a tie-in or lowering-in job and getting the pipe in easily.

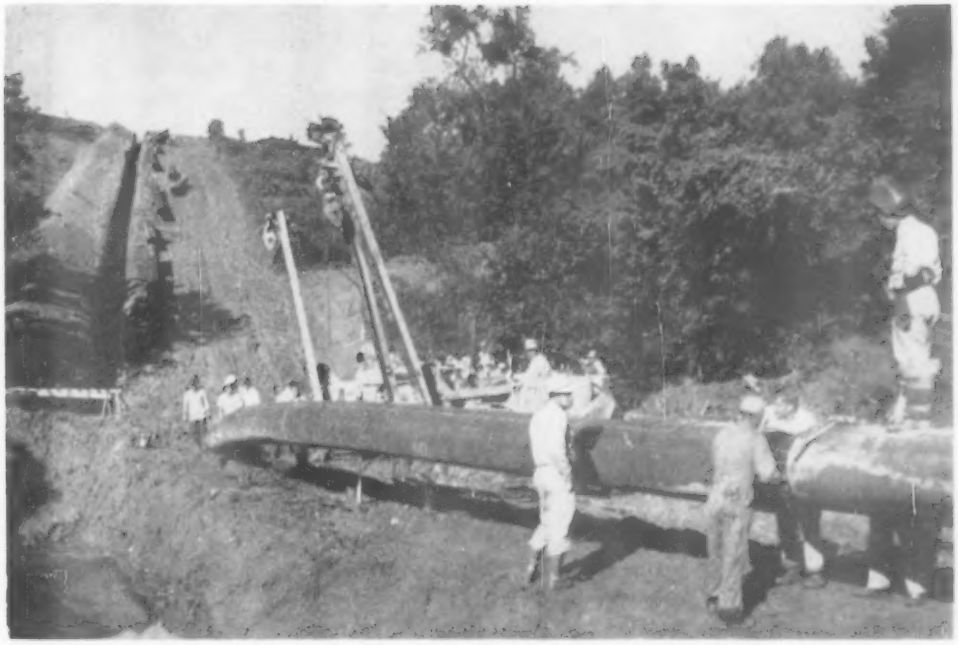
Line facts . . . T.G.T.'s large-scale looping program this year consists of 137 miles of 30-in. in Kentucky and 241 miles of 26-in. in Ohio and Kentucky. This will be the third main line for T.G.T. through the area. The original main line and the first loop are closely parallel but the second loop now being built is up to 2 miles away from the older lines.

Both contractors working on the new loop line had previously laid sections of the original line or the first loop through the same country. Spreadmen of both said the right-of-way for the new loop made it a completely different and much tougher line.

T.G.T. field engineers say that right-of-way for the new line is saving considerable pipe by taking a more direct route with fewer side bends.

Contractors working in July and August were: (1) Bechtel Corp., laying 74 miles of 30-in. from Glasgow to Danville, Ky.; (2) H. C. Price, laying 81 miles of 26-in. from near New Boston to McConnelsville, Ohio; and (3) Oklahoma Pipe Line Constructors, laying 61 miles of 26-in. from Newcomerstown to Lisbon, Ohio. Dunn Brothers, Inc., have the pipe-stringing contract.

Terrain . . . Country through which the loop extends ranges from rolling to steep hills. Rock, however, is no big problem. Ditching machines were cutting the major portion of trench and



USE OF 60-FT. joints raised output of Price's spread by 20 per cent. Here pipe gang is shown lining up one of the long joints.

little shooting was needed. With all the main drag lines were needed at most low places and water courses to clean out where ditch had sloughed off.

Pipe . . . All pipe used in the looping project is A.P.I. 5XL52. The majority of the line is being laid with 0.281-in. wall pipe but some 0.312-in. wall is used downstream of compressor stations. All road and stream crossings are being laid with ½-in. wall pipe.

Soil surveys . . . Besides their regular duties of making line changes, as-built surveys, etc., the field engineering party of T.G.T. is also making a soil-resistivity survey of the new right-of-way. This will aid in establishing needs for cathodic protection on the new line and in forewarning of possible dangerous areas on the old lines where the right-of-ways are close together.

Conventional resistivity instruments

LINE SECTIONS were pigged soon after construction was finished. This pig receiver is being removed for the permanent tiein of the block valve and blowoff assembly.

PLENTY OF SIDEBOOMS helped with rough tiens. The Price lowering-in crew had five sideboom and two tow tractors on this tiein.

COATING MACHINE on the Price spread starts down very steep hill with tow tractor (arrow) holding back.

CRADLE TRACTOR waits at bottom while tow tractor (arrow) struggles up hill backwards to winch the cradle tractor up.

COATING GANG finally starts up hill after tow tractor deadmans against a boulder and hooks on with winch line.

MADE IT. Coating crew reaches crest of hill. Entire procedure took almost 2 hours, would have required much less if one extra tow tractor had been available.

of the Shepard cane type are being used. Readings are taken at pipe depth along the ditch wall. Test leads are being installed at road crossings during construction.

Coating . . . A modified coal-tar enamel is being used on this job. The wrapping consists of a bitumen-impregnated glass mat with mica dust sprinkled on. Only one wrap is used. No kraft paper is needed since lowering in is theoretically done soon after coating. Also, with the rain and cool weather there was no danger of coating sagging.

Coating machine operators on both the Price and Oklahoma spreads had high praise for the glass-impregnated wrap. Breakage problems are practically nil with the wrap and a roll can be run out completely without once stopping the machine to restart the paper after a tear.

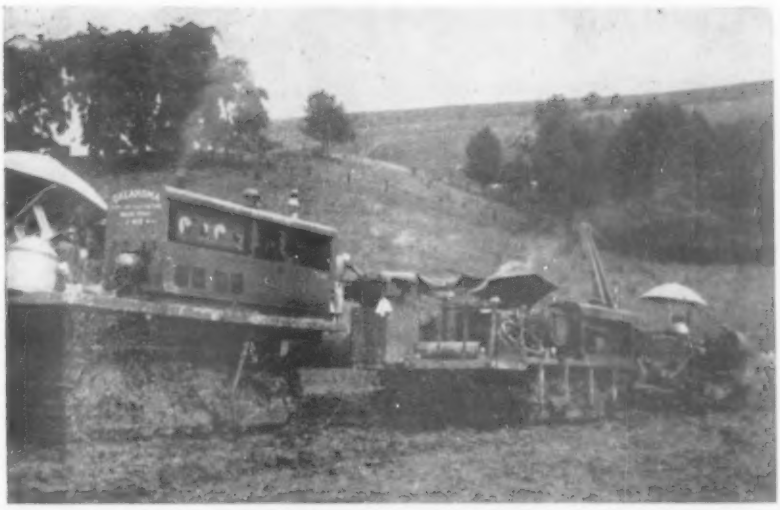
Ditch on this job is specified to afford a minimum of 24-in. cover. Because of the heavy rains a 56-58-in. ditch is being cut to take care of some sloughing off from the walls.

Double-Jointing Ups Progress

Though work had just started in late July with the 60-ft. double joints, the H. C. Price spread was having real success in raising daily footage. The spread superintendent, G. A. Reutzel, estimated that over-all output of his spread was raised some 20 per cent with the long joints.

The cost per foot would not be lowered proportionally because of the considerable cost of operating the double-jointing yard. However, Reutzel is definitely in favor of the method and is certain a cost advantage exists.

A clear idea of the advantages of double jointing seems to evolve from this spread's operation. The long joints can be readily strung, even in rough terrain. The longer joints actually make bending easier and it requires fewer firing-line welders to keep up with the



TRACTOR-MOUNTED welding machines for the Oklahoma pipe gang. Machines for stringer welders in front are mounted on medium tractors, those for hot-pass welders on heavy tractors.

pipe gang. This is because lineup operations are slightly slower with the longer joints. The Price spread uses only seven firing-line welders compared to nine normally used for pipe of this size.

Cleaning - and - coating operations, given good weather, can easily cover 10,000 to 12,000 ft. per day, so this gives no problem. With good ditch conditions lowering-in and tie-in work, using the heavy-duty sideboom tractors, can easily keep up with coating, even in areas crisscrossed with roads. So the big problem gets back to keeping enough ditch to support the extra footage welded up by the pipe gang.

With normal weather, Reutzel said he would have solved this problem by moving in right-of-way crews and ditchers early. He would have had about 25 or 30 miles of ditch cut before starting his pipe gang.

Shorter joints used first . . . When the Price spread started work on the looping project it was in very rough country with sharp-breaking hills. In such country stringing and pipe-handling problems would have been magnified with the 60-ft. joints. So for the first 20 miles of work 40-ft. joints were used. Then, when the hills flattened out a little, 60-ft. joints were put to use.

At present the policy is to string five 60-ft. joints and one 40-ft. joint. This allows some leeway in tight places and keeps from having to perhaps bend a doubled joint through the weld. The policy on bending doubled joints is to stop the bend 4 ft. away from the weld.

No automation for welders . . . The double-jointing yard in use by Price in Ohio was fully described in the May 14, 1956, issue of The Oil and Gas Journal, page 142. One of its features was an electrical arrangement whereby the pipe started turning automatically as soon as the welder struck an arc. This didn't suit field welders. So the first modification to the yard equipment was to remove that feature. Now turning of the pipe is started and stopped by a switch which the welder actuates with his foot.

Price is using eight welders in the yard and turning out up to 150 joints per day. The yard was first set up in Chauncey, Ohio, but at the time of this writing was being moved to Albany.

On the right-of-way three welders are used for stringer beads, four for hot passes, and seven for finish and cap beads. The three stringer-bead welders each cover 120° of the pipe. One squats on top, welding down to about the 2 o'clock and 10 o'clock position. The other two weld in the lower thirds of the pipe circumference, both finishing at the 6 o'clock position. A small shield made of wire and plywood is dropped over the pipe to prevent one welder's arc from interfering with another's work.

The pipe-gang welding machines are mounted on medium tractors, a must for the steep clay hills which become very slick during working periods between rains. The lowering-in crew for Price's spread used five heavy sidebooms and two tie-in welding crews of two welders each.

The cleaning crew has one medium tractor. The coating and wrapping gang uses one heavy cradle tractor and a heavy catchoff tractor. A single tow tractor serves both cleaning and wrapping gangs.

Oklahoma Spread Operations

Terrain through which the Oklahoma spread is working is not quite so rugged as that crossed by the Price spread. But it has been as wet if not wetter. Consequently, footage has not been spectacular here either, the average being about 3,300 ft. The best welding day was 180 welds or about 7,500 ft.

A noteworthy feature of the spread equipment is the use of new twin welding machines for hot-pass welders. These are 600-amp. machines, one mounted on each side of a heavy tractor. Each machine has two sets of welding leads and performs as two separate 300-amp. machines. Thus each machine supplies two welders for hot passes.

The stringer-bead welding machines are also mounted on a medium tractor. The Oklahoma spread is using only two stringers instead of the three seen on the other spread. Four hot-pass welders and nine firing-line welders are used.

Pipe stringing . . . Dunn Brothers, the subcontractor for stringing, is hauling five 60-ft. joints and one 40-ft. joint on the right-of-way on the Price spread. On the Oklahoma spread the trucks haul six 40-ft. joints.

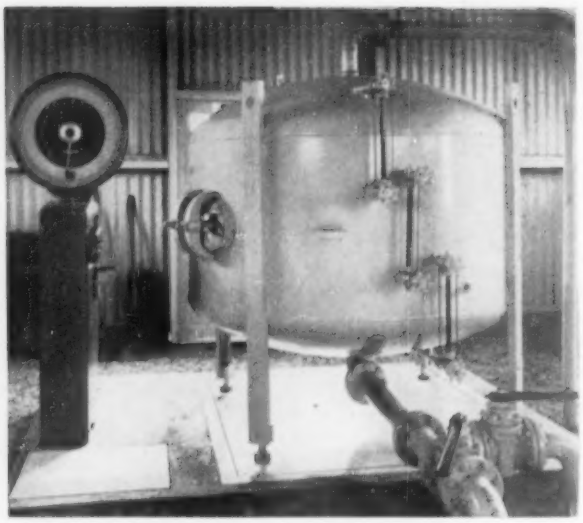
Mud and rough terrain have taken their toll of the stringing equipment. For 1 day, out of 11 new trucks which started the job on Oklahoma's spread, only 2 were still operative. The others had all been damaged in being towed down the right-of-way.

Acknowledgment

The author gratefully acknowledges the help and courtesy extended to him in visiting this work by G. A. Reutzel, spreadman for H. C. Price Co.; C. D. Barnett, chief inspector for T.G.T. on the Oklahoma spread; and Gene Gohring, spreadman for Oklahoma Pipe Line Constructors, Inc.

"A noteworthy feature is the use of new twin welding machines for the hot-pass welders. These are diesel-driven machines, one mounted on each side of a heavy tractor. Each machine has two sets of welding leads and performs as two separate 300-amp. machines."

FOUR 4-IN. METERS with dual counters and ticket printers at Pine Bend, Minn., terminal. Strainers at meter intake are jet blowdown type with quick-opening closures. Fig. 1.



TWENTY-BARREL prover tank mounted on platform scales. Scale reads to closest pound and readings are estimated to closest ½ lb. Fig. 3.

How Minnesota Pipe Line Is

Metering Those Heavy Canadian Crudes

Thick, waxy Canadian crudes are being successfully metered by Minnesota Pipe Line. Custody transfer by meters starts this fall. Tests by Minnesota on variations in meter factors may lead to an air-conditioned meter house to keep ambient and oil temperature equal.

by C. F. Barnard
Minnesota Pipe Line Co.

METERING of high-viscosity, high-wax-content crude oil in the cold weather of Minnesota has resulted in some interesting problems and practices by Minnesota Pipe Line Co. But metering this type of crude has been highly successful. Custody transfer by meter will start this fall from Minnesota Pipe Line to Great Northern Oil Co.

One of the most interesting problems that has arisen is that of explaining a rise in the amount of the meter factor with increasing ambient temperature. As a result, the company is now considering temperature-conditioning of its meter building. The object will be to keep the ambient temperature at all times equal to the oil temperature in the line.

As an aid to the metering and sampling program, the company is also using a new type of cut-point gravitometer. The device allows a slip stream from the line to flow through a fixed-volume coil which is suspended from a strain-gage weigh beam.

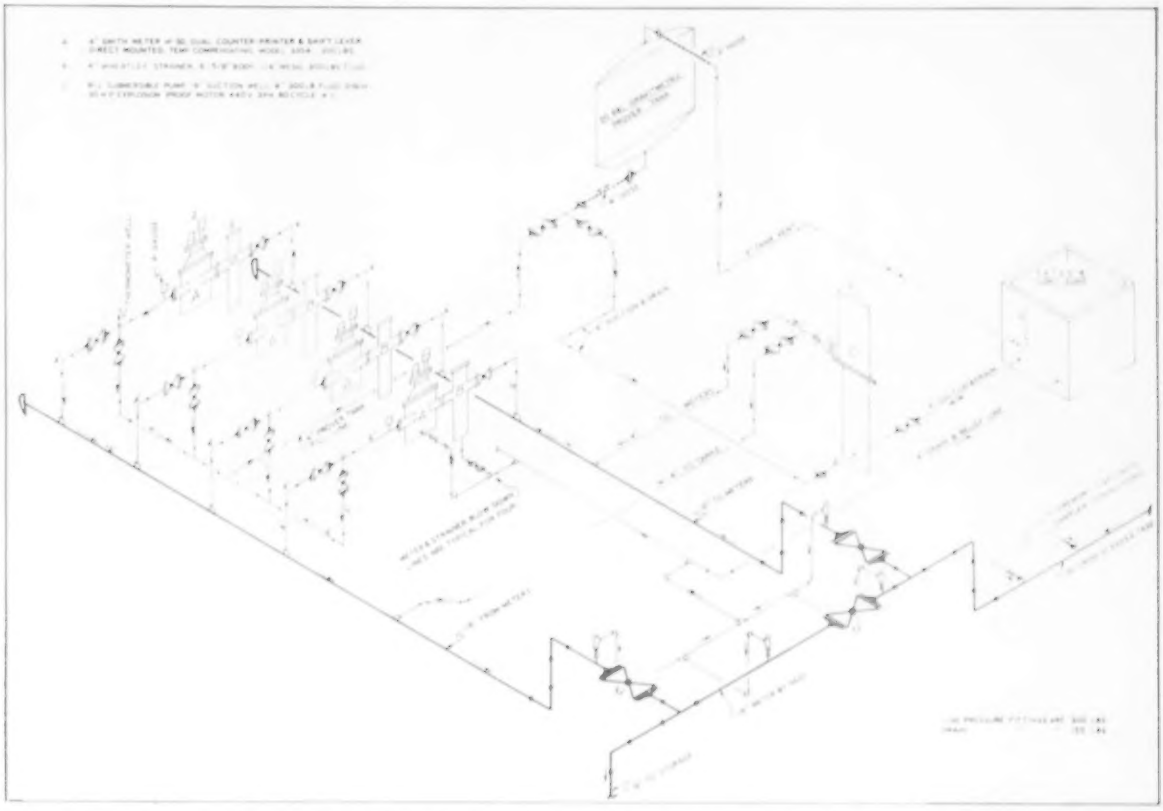
Crude Oil Characteristics and Metering Methods

Canadian crude oils are received by Minnesota Pipe Line at Clearbrook, Minn. Separate batches for two consignees are made up and are pumped from Clearbrook to Pine Bend and St. Paul Park, Minn. The crude oil delivered to Great Northern Oil Co. through a meter bank at Pine Bend is a mixture of medium-gravity Fosterton and light-gravity Pembina.

Light-gravity Pembina is delivered in the other batch to Northwestern Refining Co.'s tanks at St. Paul Park. The viscosity of the 22° A.P.I. Fosterton crude ranges from 2,700 S.U.s. maximum in the winter to 500 S.U.s. during the summer, and the viscosity of the 36° A.P.I. Pembina mix ranges from 160 S.U.s. to 60 S.U.s. from winter to summer. The composition of the mixture for Great Northern is on the order of 60 per cent medium and 40 per cent light crudes.

The meter bank at Pine Bend consists of four 4-in. Smith W-50 meters with dual large-numeral-type counter and ticket printers and a shifting mechanism (see Fig. 1 and Fig. 2). Each meter is temperature compensated. A Charles Wheatley jet blowdown type of strainer is connected ahead of each meter. The meter bank is manifolded so that the crude-oil stream may be directed through any or all of the four; also, any one meter may be calibrated while the full stream is being delivered. The full stream may be directed through the meter bank or it may bypass the meter bank (See Fig. 7).

Gravimetric proving in accordance



METERING ARRANGEMENT is shown in this isometric drawing. Equipment is housed and building may later be temperature conditioned so room ambient equals temperature of oil in line. Fig. 2.

with A.P.I. Code 1101 is used. In this method of calibrating meters, the amount of oil which clings to the walls of the prover tank, either because of the viscosity effect or the precipitation of wax crystals, is determined by the difference in weighings. This amount of oil is not determinable, the author feels, with volumetric prover tanks. Therefore, because the crudes likely to be measured were either of high-viscosity or high-wax content, we selected the gravimetric method.

The proving facilities consist of a 20-bbl. proving tank mounted on a platform scale, that has a total capacity of 11,250 lb. (see Fig. 3); a specific gravity balance that can be read directly to the fourth decimal place (see Fig. 4); a sump with a vertical can type pump for emptying the proving tank. This sump is also used as the terminal sump (see Fig. 5).

Other facilities used in measuring the crude oil are an automatic sampler that takes a sample proportional to time from a continuous sample stream, (see Fig. 6); and the usual lab facilities of crude-oil heater, test tubes, and a centrifuge.

A little over 5.6 million barrels of crude oil have been metered since the installation was completed in October 1955. Three meters were originally installed and the fourth was added early in April 1956.

A comparison of metered barrels versus tank-gaged barrels was begun on March 1, 1956. Records were maintained and show that a total of 3,159,711 bbl. metered versus 3,160,543 bbl. gaged with a difference of 832 bbl. for the period between March 1 and July 31, 1956. This is a difference of 0.03 per cent.

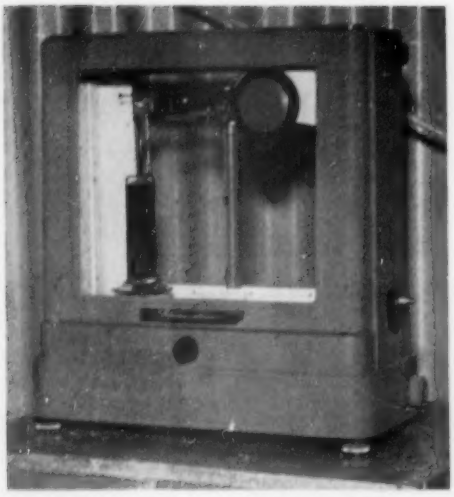
The records were maintained to show that this type of crude oil can be metered with an accuracy comparable to tank gaging and to justify the custody transfer of crude oil by meters. The custody transfer of the crude oil from Minnesota Pipe Line Co. to Great Northern Oil Co. will be made by meters beginning September 1, 1956.

The following tabulation shows the comparison of the two methods of measuring crude oil by months.

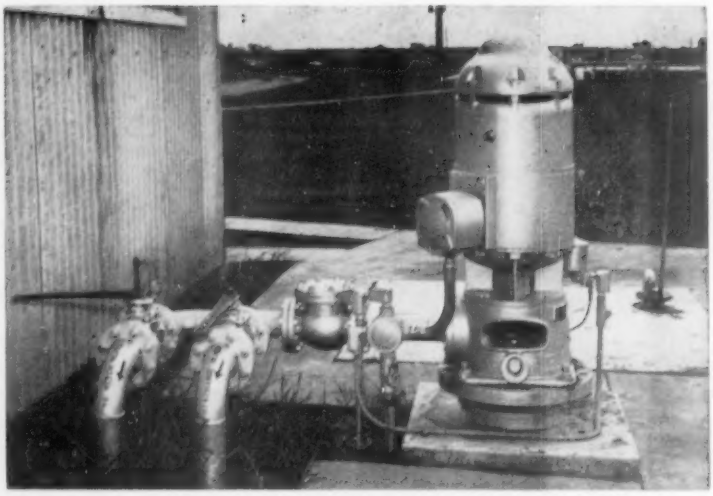
Month—	Metered barrels	Tank gage barrels	Tank gage over meters (short meter)	Per cent difference tank gage over meters (tank gage short meter)
March	586,586	585,664	(922)	(0.16)
April	578,307	577,368	(939)	(0.16)
May	557,817	558,474	657	0.12
June	656,828	657,737	909	0.44
July	780,173	781,300	1,127	0.14
Accumulated total	3,159,711	3,160,543	832	0.03

THE AUTHOR

Charles F. Barnard is chief engineer of Minnesota Pipe Line Co. He joined the company in September 1954. Previously he had been a senior engineer with Interstate Oil Pipe Line Co., having been with that company since 1946. He is a 1940 graduate of Texas Technological College with a B.S. in electrical engineering. Prior to his entrance to military service in World War II, he worked for a short time with General Electric X-Ray Corp.



GRAVITY BALANCE reads directly in specific gravity to fourth decimal. Temperature is by thermometer in beaker. Fig. 4.



SUMP ARRANGEMENT uses can type of vertical pump, has two discharge lines so that sump can be either metered or pumped directly into line if it has already gone through meter. Fig. 5.

Meter-factor records are shown in the following tabulation for the period of the comparison:

Date—	°A.P.I. gravity at 60° F.	No. 1 meter	No. 2 meter	No. 3 meter	No. 4 meter
February 27	27.1		0.9949	0.9978	0.9978
February 28	26.4		0.9967	0.9991	0.9976
March 13	27.8		0.9961	1.0004	0.9992
April 13	27.6	0.9980	0.9985	1.0003	0.9997
April 18	27.3	0.9972	0.9968	0.9982	0.9984
May 23	26.9	0.9946	0.9954	0.9964	0.9966
July 20	25.7	0.9997	0.9979	0.9989	1.0014

After reviewing the meter-calibration report of July 20, 1956, it was believed that the No. 4 meter was experiencing difficulty with its temperature compensator. An inquiry was made to the meter manufacturer for its recommendation of a procedure to prove the temperature compensator. With slight alterations to this recommended procedure a method was devised that was thought suitable to our need for proving the temperature compensator.

Gravimetric-Meter Proving

Normally the gravimetric-meter proving is done as follows:

General . . . Meters shall be calibrated under conditions approximating as nearly as possible actual operating conditions. Calibration is made when any of the following conditions exist:

1. Thirty days have elapsed since last calibration.
2. Flow rate has changed 100 bbl. per hour or more and new rate will obtain for at least 50,000 bbl.
3. Flow indicated by meters is consistently over or short as compared with either Clearbrook or consignee's storage tanks, and such gain or loss cannot be otherwise fully explained.
4. The viscosity of the crude oil has changed, which may be detected by a minimum of 10° F. change in the crude oil or a prolonged change in gravity.
5. Meter has been repaired since last calibration.
6. Any other condition which might affect the accuracy of the meter.

The consignee is notified sufficiently in advance of a meter calibration to permit him to arrange for a witness to be present at the calibration. All lubricated plug valves are lubricated at least 1 hour prior to calibration.

The pressure drop across strainers at time of calibration it held to normal minimum pressure drop for the existing flow rate. Gage glasses on prover are cleaned immediately after each test, and all other equipment checked and placed in ready condition.

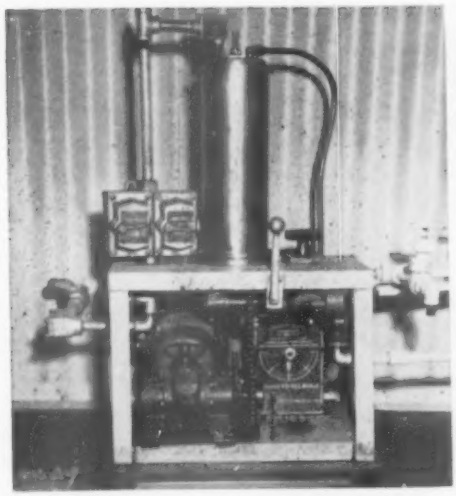
During test runs, all doors and windows are closed to prevent drafts on the Christian Becker balance during specific gravity determinations.

Calibration procedure . . . Preparatory steps for calibration are as follows:

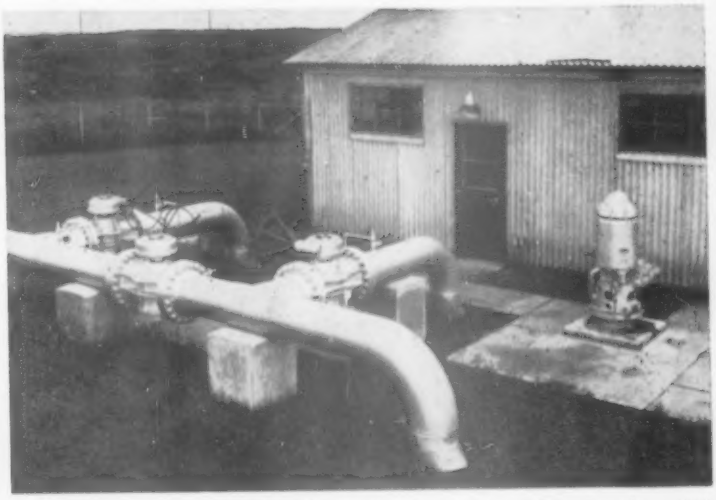
1. Fill prover tank with oil through each meter to purge lines of old oil. Finish filling tank with first meter to be calibrated with outlet valve of that meter closed.
2. While filling prover tank, adjust rate valve between meter and tank so rate through the meter equals the rate at which meter is operating when measuring stream. Once the rate valve is set, do not operate it again until test is completed.
3. When prover tank is full, close meter-prover outlet valve and open meter-line outlet valve to permit meter to continue turning.
4. Allow oil to remain in tank for about 5 minutes to condition the tank for temperature, then pump tank down into meter outlet header leaving about 300 lb. of oil in tank.
5. Adjust balance counterweights until a specific gravity of 1.0000 is obtained for boiled distilled water cooled to 60° F. Adjust balance vernier to zero.

In making the test run the following instructions apply:

1. Record line temperature.
2. With about 300 lb. of oil in tank read and record dial on weigh scale to the nearest ½ lb.
3. Read and record line pressure through meters.
4. Close the meter-line outlet valve.
5. Read meter to nearest 1/1,000 bbl. and record.
6. Record observed °A.P.I. gravity and temperature in °F. with a hydrometer of a sample withdrawn from the line just prior to a run to the prover tank.
7. Open meter-prover outlet valve fully but smoothly.
8. Determine flow rate through meter by timing register with stop watch. Record.
9. Read and record back pressure on meter.
10. Withdraw a sample from the sample line and determine specific grav-



COMPOSITE SAMPLES from stream are taken by this device on a time base. Fig. 6.



MANIFOLD to allow either bypassing or directing of stream through meters which are in house at rear. Fig. 7.

ity by using the Christian Becker balance in the following manner:

(a) Level apparatus as per instructions with balance.

(b) Balance the beam with plummet in air by determining equal swing of pointer on either side of zero. Be sure plummet is clean and dry. The plummet is to be cleaned by immersion in carbon tetrachloride. Handle plummet with tweezers or forceps, do not handle with hands or fingers. See that all bearings are correctly placed so that they bear on knife edges. Zero the vernier scale with the beam and plummet in balance.

(c) Place a long-stem thermometer in the crude-oil sample beaker so that the temperature may be determined as soon as the specific gravity is determined. Allow about 2 minutes for the plummet to come to crude-oil temperature before determining specific gravity.

(d) Read and record the temperature to nearest ½° F.

(e) Read and record the specific gravity to the nearest (0.0001) ten-thousandths.

(f) Re-check the zero of the vernier and the beam balance.

11. When tank is filled, close meter-prover outlet valve.

12. Read and record meter to nearest 1/1,000 bbl.

13. Open meter-line outlet valve.

14. Read and record weight indicated on scale dial to nearest ½ lb.

15. Record observed °A.P.I. gravity and temperature in °F. with hydrometer of a sample withdrawn from the line just after completing the run to the prover tank. If the °A.P.I. is not the same as at the start of the run to the prover, discard the data and make another run to prover tank. The °A.P.I. gravity corrected to 60° F. shall be the same for the beginning and end of a run to the prover tank.

16. Open valve between prover and sump pump and pump oil from prover into meter outlet header leaving about 300 lb. of oil in prover.

17. Stop pump and close valve between prover and sump pump.

The above procedure completes one test run. Additional runs are to be made until meter factors obtained from two runs out of three agree within 0.0005. If acceptable agreement is not obtained in four consecutive runs, a careful check shall be made on the meter, proving equipment, and all valves involved to locate and remedy the difficulty. When acceptable agreement has been obtained, the prover tank is to be completely emptied, all meter proving valves closed.

Meter factor computation . . . The meter factors determined by the following procedure will be used to adjust the gross barrels recorded by the meters to gross barrels meter corrected.

1. Fill in lines 1, 2, 4, 5, 9, 10, 11, 12, and 13 on Form MPL 106 shown in Fig. 8.

2. Reduce observed specific gravity, line 2 to specific gravity at 60° F. using Table 23, A.S.T.M. Petroleum Measurement Tables. Enter in line 3.

3. Subtract line 5 from line 4 to obtain net weight in prover. Enter in line 6.

4. From Table 26, A.S.T.M. Petroleum Measurement Tables, find pounds per U. S. gallon corresponding to specific gravity entered in line 3. Multiply pounds per U. S. gallon by 42 to obtain pounds per barrel. Enter pounds per barrel in line 7.

5. Divide line 6 by line 7 and enter result on line 8. Gross barrels in prover. Carry division to nearest 0.001 bbl.

6. Subtract line 13 from line 12 and enter result on line 14, barrels registered.

7. Divide line 8 by line 14 to obtain line 15, which is the meter factor determined by one test run.

8. Average the meter factors determined by the two selected tests and enter the result on line 16. This is the meter factor to be used.

9. If the new factor does not check the last previous factor for the same stock and flow rate within 0.0025, additional determinations must be made until three factors have been obtained which check each other within 0.0005. This provides an index to the condition of the meter and a double check against an error in determining the new meter factor.

Reports . . . Reports shall be numbered consecutively beginning with the first of each year. They shall be prepared in triplicate, and distributed as follows:

Original: General office.

Duplicate: Great northern refinery.

Triplicate: Retain in file at meter terminal.

The original report will be checked in the general office, and any errors found will be corrected on the original.

After the original copy of the report has been verified, a verifaxed copy will be sent to the meter terminal and to the consignee. See Fig. 8 for a sample meter report.

Proving Temperature Compensator

To the above proving procedure the following was added in order to prove the temperature compensator:

1. Temperature compensator proving

No. 1

MINNESOTA PIPE LINE COMPANY

METER CALIBRATION REPORT

Date 2/28 19 56 Location Pine Bend Meter No. 1

Make and Size of Meter Smith 4 inch Type of Crude Mix-Mix

Opening and closing hydrometer °API @ °F
C 24.9/35 24.8/35 24.9/35 24.9/35
O 24.9/35 24.8/35 25.0/35 24.9/35

MEASUREMENT DATA	RUN #1	RUN #2	RUN #3	RUN #4
(1) Rate—Barrels per hour	600	600	600	600
(2) Observed specific gravity and temp.	.9051/38	.9056/38	.9054/38	.9055/38
(3) Corrected specific gravity @ 60° F.	.8972	.8977	.8975	.8976
(4) Closing scale reading (lbs.)	5459.0	5518.5	5413.5	5482.0
(5) Opening scale reading (lbs.)	306.5	314.5	294.5	305.0
(6) Net weight in prover (lbs.)	5152.5	5206.0	5119.0	5177.0
(7) Conversion factor (lbs. per bbl.)	313.786	313.963	313.891	313.925
(8) Gross barrels in prover (6) ÷ (7)	16.420	16.575	16.308	16.491
(9) Line pressure (PSI)	30	30	30	30
(10) Calibration pressure (PSI)	30	30	30	30
(11) Line temperature (°F.)	35	35	35	35
(12) Closing meter reading	4398.031	4396.325	4467.801	4512.359
(13) Opening meter reading	4311.560	4379.711	4451.410	4495.802
(14) Barrels registered	16.471	16.614	16.391	16.559
(15) Meter factor (8) ÷ (14)	.9969	.9977	.9949	.9956

(16) Average Meter Factor .9967

Signed by J. Christmann Signed by D. L. Johnson

For D.M.P. Co For Minnesota Pipe Line Co

SAMPLE of meter calibration report. Fig. 8.

shall be done under conditions approximating as nearly as possible actual operating conditions.

2. Temperature compensators shall be proved whenever:

(a) Meter factor varies more than 0.0025 from previous prover factor and it becomes impossible to obtain three runs with factors that do not vary more than 0.0005.

(b) A new temperature compensator is installed.

Testing procedure . . . The preparatory steps are the same as those outlined for meter proving under "calibration procedure" with the following additions:

1. Valve off meter whose temperature compensator is to be checked. Print ticket and insert new ticket in ticket printer.

2. Remove temperature compensator bulb from meter and plug opening with a steel bull plug.

3. Immerse temperature compensator bulb in a thermos jug containing water at a temperature of 72° to 75° F.

4. Immerse long-stem thermometer in thermos jug along side of temperature compensator bulb.

5. Run four calibration tests on meter and record temperature of water in thermos jug. At the end of four runs print ticket with meter stopped and insert and print new ticket.

6. Immerse temperature compensator and long-stem thermometer in thermos jug filled with water at a temperature of 32° to 40° F.

7. Run four calibration tests and record temperature of water in thermos jug.

8. Temperature of water must remain constant within ½° F. during calibration test run.

9. Shut valve to meter, replace temperature compensator bulb in meter, print ticket and insert new ticket, and put meter back on stream if needed.

Meter factor computation . . . The meter factor determined by the following procedure will be used to determine whether or not the temperature compensator is functioning properly.

1. Multiply the meter factor (line 15) determined by the ratio of volume reduction factor for the water temperature to the volume reduction factor for the line temperature. These volume reduction factors will be taken from Table 24 of the A.S.T.M.-I.P. Petroleum Measurement Tables.

Example:

(Line 15) Meter factor = line 8/line 14.

Correct meter factor

$$= (\text{line } 8/\text{line } 14)\,(VRF_1/VRF_2)$$

Where:

VRF_1 = volume reduction factor from Table 24 for temperature of water that temperature compensator bulb is emersed in.

VRF_2 = volume reduction factor from Table 24 for temperature of crude oil in the line during meter run.

2. At least two meter factors obtained from the four tests at each water-bath temperature for the temperature compensator bulb should be within 0.0005 of each other. If two are not obtained within this limit additional runs should be made until three runs are obtained within this limit. If it is impossible to obtain the above results within a reasonable number of runs the matter should be taken up with the meter manufacturer for recommendations.

3. The meter ticket printed for the test runs at each water-bath temperature should be corrected by multiplying the barrels registered by the ratio of the volume reduction factor from Table 24 for line temperature to the volume-reduction factor from Table 24 for the water-bath temperature.

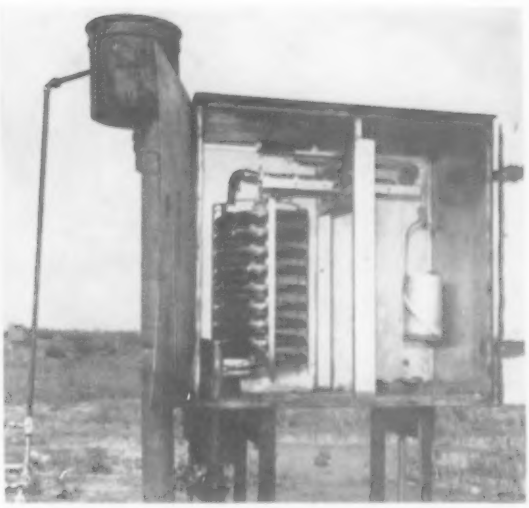
Fig. 9 shows the setup for temperature-compensator proving.

Factor increases with ambient . . . After the temperature-compensator proving procedure had been run on the No. 4 meter with the compensator bulb in a water bath of 76° F. and 34° F. and with a crude-oil line temperature of 64° F. it was found that the meter factor obtained in each case was 1.0015. This seemed to prove that the temperature compensator was functioning satisfactorily. This left us unable to account for the high meter factor for the No. 4 meter.

To make certain that we had made a complete investigation we shrouded the ambient temperature bellows with an ice pack for a period of 15 minutes. With the ice pack covering the ambient temperature bellows we reinserted the temperature-compensator bulb in the crude-oil stream and ran our normal proving procedure on this particular meter. The meter factor obtained with the ice pack on the ambient temperature bellows was lowered to 1.0010.

We then reviewed our meter-factor record and realized that the meter factor had steadily increased as the ambient temperatures increased with the exception of the factors obtained on April 18 and May 23, 1956. It is believed that the ambient temperature bellows does not correct the same amount for different ambient temperatures; however, the data obtained on April 18 and May 23, 1956, might tend to dis-

METER temperature compensator bulb in water bath as proof test is made on temperature compensator. Fig. 9.



NOVEL continuous gravity indicator used as cut-point device. Change in weight between 20° and 42° A.P.I. gravity is measured. Fig. 10.

credit this thinking. The lower meter factors obtained on these two dates might be explained by the fact that the viscosity of the heavy type of crude changes very rapidly with temperature change. The increased temperature of the crude oil lowered the viscosity so that slippage through the meter overcame the ambient-temperature effect. Once the crude had warmed up to a certain point the ambient-temperature effect appears to again overcome the meter-slippage effect due to a lesser rate of change in viscosity of the crude oil.

Air-conditioned meter room . . . The result of the increased meter factor with increased ambient temperature and the test made as described above, indicate that our meter-proving procedure should be altered to take into consideration the change in ambient temperature.

We find that in proving our meter the measurement of the specific gravity is the most critical measurement we make. This can be done accurately if extreme precaution and care are used in measuring the specific gravity with the balance. We believe that greater meter accuracy can be obtained if the meter building could be maintained at the same temperature as the crude oil in the pipeline. We are investigating the possibility of insulating, heating, and air-conditioning the meter building toward this end.

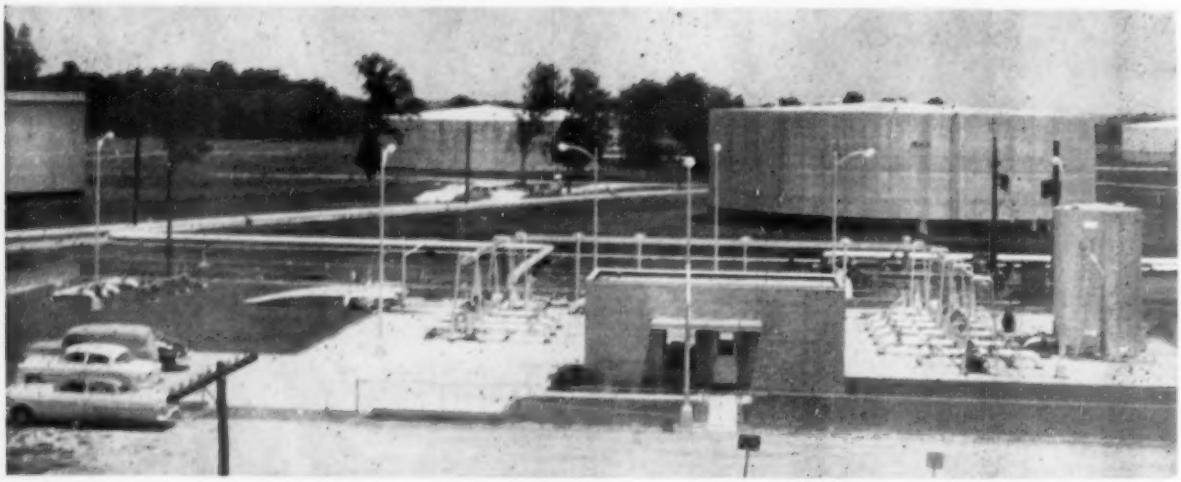
New cut-point device . . . Another point of interest in our crude-oil-measuring methods is determining the cut point between batches of segregated crude oil. We are using a method devised for the taconite industry in Minnesota for continuously measuring specific gravity. This instrument is shown in Fig. 10. It consists of a sample stream flowing into a baffled hopper to eliminate air bubbles and then flowing through a fixed volume of coiled tubing suspended on a counterbalanced weigh beam that is linked to a 1-lb. Baldwin SR4 load beam.

The volume of the coil is such that it will result in a 1-lb. differential weight between 42° and 20° A.P.I. gravity. The load beam is coupled electrically to an amplifier driving a strip chart recorder calibrated from 20° to 42° A.P.I. The instrument is calibrated by recirculating a known gravity of crude oil at one extreme, and then recirculating known gravity of crude oil at the other extreme. This instrument follows the change of gravity in an interface within 0.1° A.P.I. of that obtained by the hydrometer method. For the instrument to maintain its calibration it should be energized continuously as it tends to drift after being deenergized for an appreciable period of time.

To utilize the instrument we are devising a method where the gagers may recalibrate with a hydrometer reading by changing the counterbalance weights. Heretofore the gagers have had to take samples in a hydrometer jar from the pipeline in subzero weather. They will now be able to remain in a heated building and observe the cut point on the strip chart.

We believe that by practicing the foregoing we will eliminate hazards to gaging personnel by keeping them off of tanks and out of the subzero weather encountered here in Minnesota.

CRUDE OIL TEST LAB facilities with oil heater and centrifuge. Fig. 11.



METER TERMINAL viewed from the entrance showing placement of calibration tank, scraper traps, and relief header (at extreme left). Fig. 1.

How Interstate Pipe Line uses . . .

P.D. Meters to Streamline Terminal Work

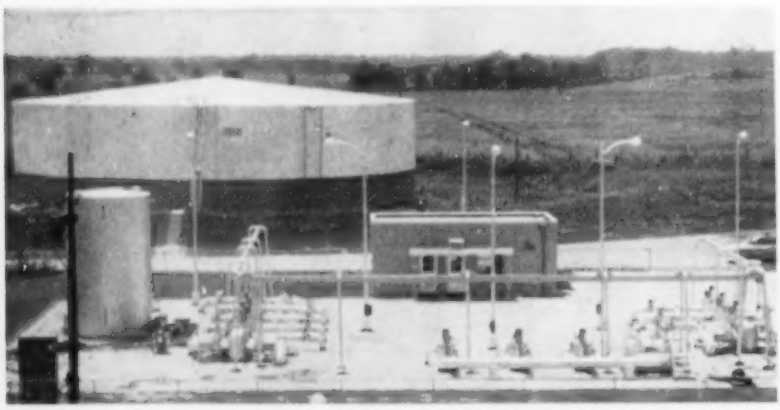
Here are details on the pipeline industry's largest meter installation, 10 p.d. meters handling 275,000 bbl. of crude oil per day. Custody transfer from pipeline to refinery is by meter with some crude oil going directly to stills. The system has greatly simplified operation, allowed more accurate control of pipelines, and reduced operating costs.

by Wallace K. Luse
Interstate Oil Pipe Line Co.

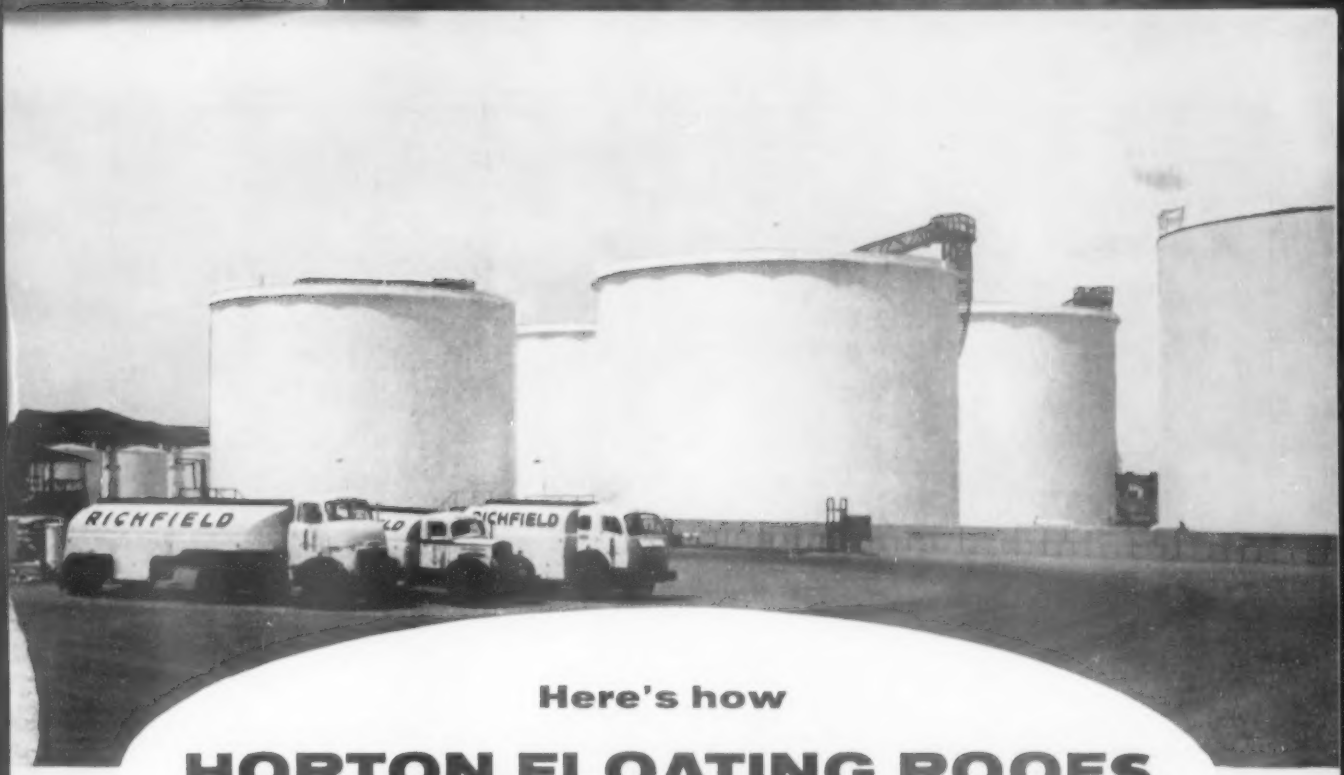
CONSIDER a terminal tank farm of 41 tanks, receiving seven grades of crude oil totaling 275,000 bbl. daily through three separate pipeline systems. The crude delivered to the tank farm was gaged, temperatures and samples taken for custody transfer, and gaged for dispatching control of the three pipelines, all by hand methods. This was the situation at Interstate Oil Pipe Line Co.'s Anchorage terminal prior to the installation of a modern positive-displacement-meter terminal.

Interstate has three trunk pipeline systems delivering crude oil to a refinery tank farm at Anchorage, near Baton Rouge. Two of these systems are 16-in. lines transporting oil from South Louisiana and Southwest Louisiana producing areas. For refinery purposes the two streams are classified as a single grade of oil; however, it was necessary to put them into separate tanks which were gaged every 2 hours for dispatching control of the pipelines and gaged again when tank changes were necessary.

The other line coming from North Louisiana with connection from Texas and Arkansas is primarily a 22-in. line with short section of dual 12-in. lines. This system carries six grades of oil which must be segregated in tankage and was hand gaged every hour for dispatching control in addition to between hour opening and closing gages as required by batch arrivals. Hand samples were taken at sample points located throughout the tank farm. Gag-



VIEW FROM REAR of installation shows relative position of the three banks. The electrical control center and transformers are at left. Fig. 2.



Here's how

HORTON FLOATING ROOFS

control evaporation loss

at Phoenix terminal

Four storage tanks equipped with Horton® Double-Deck Floating Roofs are reducing evaporation losses, corrosion and fire hazard at the Richfield Oil Corporation's Phoenix, Arizona, terminal on the Southern Pacific Pipe Line. The Horton Floating Roofs float directly on the surface of the liquid in the tanks, eliminating space for air-vapor mixture to form, be vented and lost.

Horton Floating Roofs are built in three types—Double-Deck, Pontoon and Pan. Write our nearest office for further information, estimates or quotations.

Below: View inside one of Richfield Oil Corporation's tanks equipped with a Horton Double-Deck Floating Roof. The Horton Seal around the edge of the roof efficiently closes the space between the deck and the tank shell.

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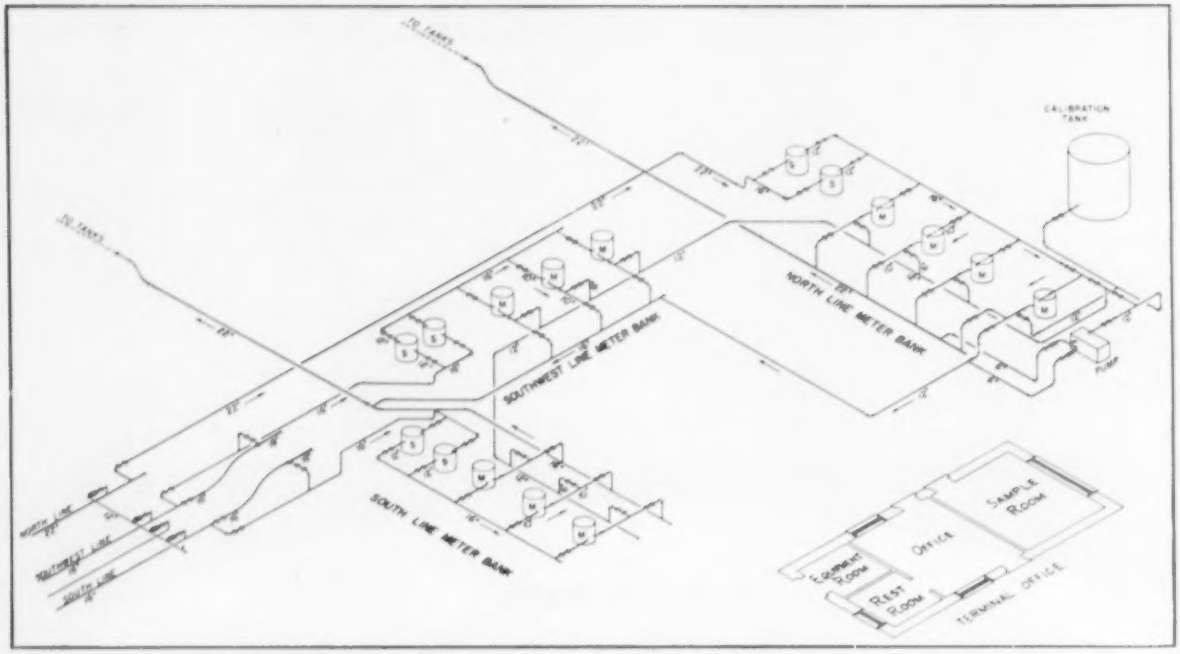


FLOW DIAGRAMS of the piping and floor plan of building. Drain lines have been eliminated for clarity. Fig. 3.

ing practice required that opening and closing gages and tank-temperature readings be witnessed by refinery gagers. Responsibility for tank changes fell to the pipeline personnel.

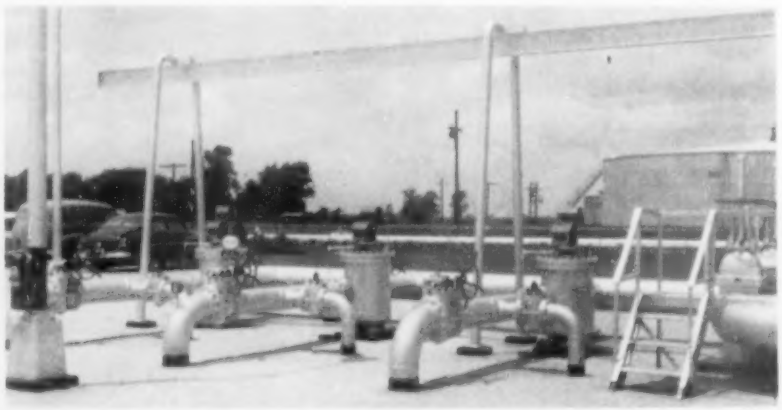
Meters change operation . . . The meter terminal includes three meter banks, one bank for each of the three pipeline systems. The three banks and the operating office were installed at a central point in the tank farm using an area about 100 ft. square. This compact arrangement has eliminated the need for pipeline-gager transportation over the tank farm and permits hourly reading of all meters for closer dispatching control. Printer heads on the meters print temperature-corrected delivery tickets at 7:00 a.m. and upon batch arrival. An electronic "batch detector" and automatic samplers were installed to eliminate hand sampling. Over-all views are shown in Figs. 1 and 2.

The responsibility for tank changes has been transferred to the refinery personnel. However, this procedure has been greatly simplified. The South Louisiana and Southwest Louisiana streams are combined in a single 22-in. line leaving the meter banks. Several tanks—usually two or three—are opened to receive the stream, and at the same time tank-farm pumps operate to relay much of the stream directly to the refinery. In this way tank changes may be spaced several days apart. Since the crude is measured by the meters for custody transfer, knowledge of the approximate level of the tank to prevent overfilling is all that is required. This information is obtained by periodic readings of a target gage on the side of the tank.

The North Louisiana stream delivers six grades of crude in batches ranging from 50,000 to 300,000 bbl. To receive this stream it is now customary to manifold enough tanks to store the entire batch. This is set up ahead of time; and when notification is given by the pipeline gager that the batch has arrived, the switch is made by operation of valves in tank-farm headers. At times a considerable part of this stream is also relayed directly to the refinery and tank level is checked by the target gages. The ability to relay to the refinery is one of the chief advantages of the metering plan since it substantially reduces evaporation losses.

The meter terminal consists of ten 2,800-bbl. per hour positive-displacement meters, six strainers, calibration tank and pump, sump, scraper traps, relief line and manifold, electrical control center, and office building. The three meter banks form three sides of a square with the fourth side occupied by the office. The dimensions of the square are approximately 100 ft. to the side, which is believed to be about as compact as possible consistent with sound engineering practice and workability.

The South Louisiana and Southwest Louisiana stream meter banks consist



ACCESS TO ALL METERS is easy since majority of piping in bank area is belowground. Steps shown above lead to strainer valves. Fig. 4.

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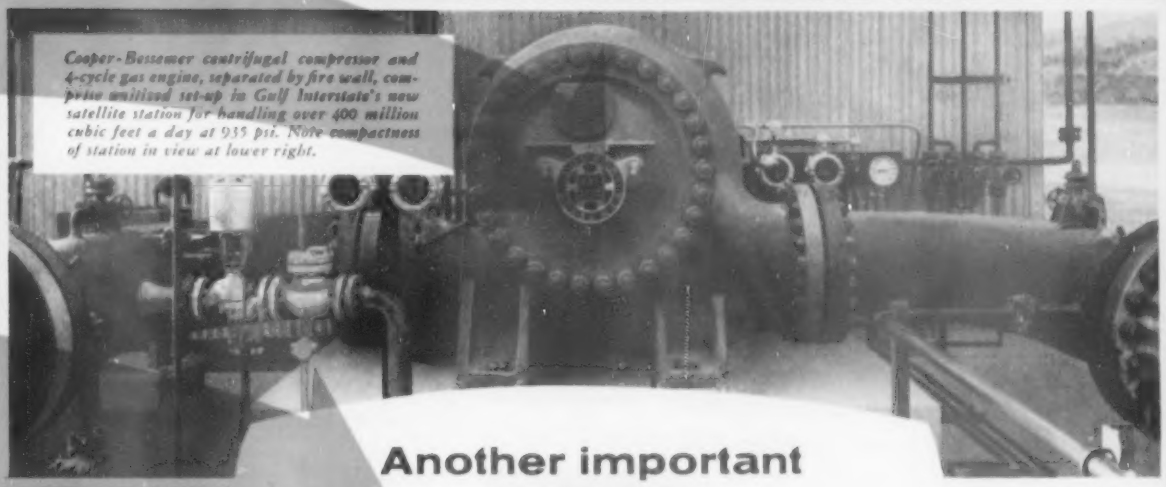
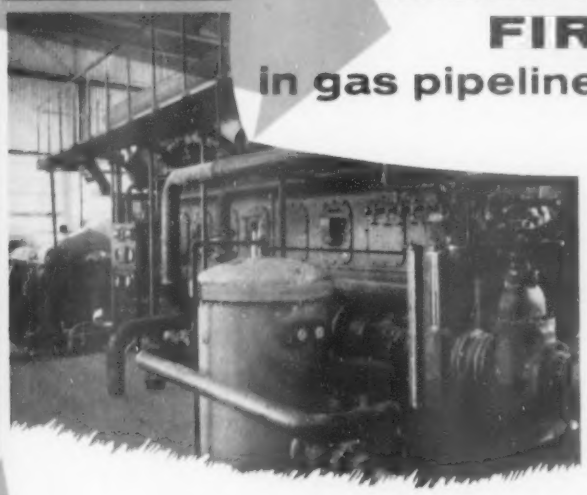


Cooper-Bessemer centrifugal compressor and 4-cycle gas engine, separated by fire wall, comprise unitized set-up in Gulf Interstate's new satellite station for handling over 400 million cubic feet a day at 935 psi. Note compactness of station in view at lower right.

Another important FIRST in gas pipeline transmission



Cooper-Bessemer ENGINE-DRIVEN centrifugal COMPRESSORS

● A new chapter in the progress of gas transmission has been opened at Gulf Interstate Gas Company's new compressor station near Stanton, Kentucky. Here, a Cooper-Bessemer engine-driven centrifugal compressor is the first such unit to go into regular service on a main gas transmission line.

This precedent is a tribute to Gulf Interstate management for alertness and decisive action in the application of promising new ideas . . . here successfully applied through the close cooperation of Gulf Interstate and Cooper-Bessemer engineering. These are a few of the highly significant features:

SATELLITE STATION . . . for remotely controlled automatic operation—*another* "first" for Cooper-Bessemer engine-driven centrifugals.

IDEAL FLEXIBILITY . . . combines continuous heavy-duty performance with ability to meet peak demands. Greatly increases flexibility of line-to-market gas transmission.

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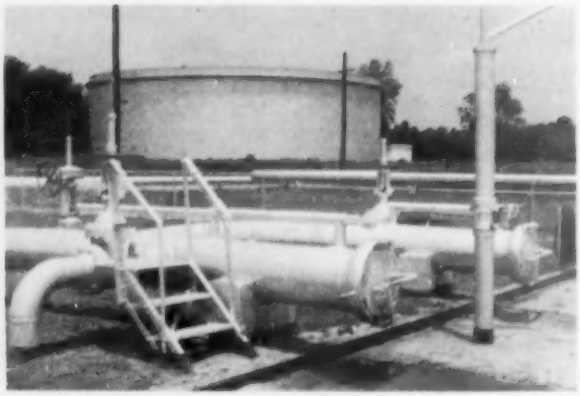
THE 12-IN. RELIEF HEADER with rupture disk assemblies. Fig. 5.



SCRAPER TRAPS with hoist to load scrapers on trucks. Fig. 6.

of three meters and two strainers each with provision for installation of a fourth meter if required in the future. The North Louisiana stream bank includes two strainers and four meters.

The fourth meter is piped in such a way that it can be operated as a standby meter on the North Louisiana bank or as a master meter for the entire meter terminal. Any one of the other nine meters may be connected in series with the master meter and calibrated simultaneously with the master into the calibration tank. Once a factor has been obtained on the master, the remaining two meters in the bank may then be calibrated against the master with the oil going directly to proper tankage. This feature reduces the use of the calibration tank by two-thirds and materially speeds up the over-all calibration time. A diagram of the piping is shown in Fig. 3.

The header on each bank leading from the strainers to the meters was installed aboveground; but the header leading to tankage and calibration tank lines was placed underground, providing walk-in accessibility to read meters, change tickets, and operate valves. This arrangement is shown in Fig. 4.

A safety platform was installed in order that strainer gate valves could be worked. A single monorail-type hoist, continuous over all meters, strainers, and the calibration tank pump, was erected to make servicing easier. Seven mercury-vapor lights on 28-ft. standards provide adequate illumination for operation, calibration, or maintenance at night if necessary. The area occupied by the meter banks, calibration tank, pumps, and scraper traps was hardsurfaced and enclosed by a 6-in. concrete curb. This enclosed area is drained to a tank-farm ditch leading to a water-oil separator which will recover the oil in case of gasket failure or other oil spill.

Relief header . . . A relief header, shown in Fig. 5, was installed just outside of the meter area to protect the meters from excessive pressures. This header is connected to each of the three incoming lines with rupture disk assemblies and to a tank-farm tank set aside for this purpose. Another rupture disk of lower rating was installed in the tank line so that the header could be kept "dry." A float switch in the header sounds an alarm if the header begins to fill up either from a leak or a ruptured disk. Scraper traps shown in Fig. 6 were installed on the two 16-in. lines in the same area and provision made for installation of a trap on the 22-in. line if required in the future.

The office building of modern brick and tile construction includes an air-conditioned office and washroom facilities for the gager, a sample room, and an equipment room for communication facilities.

The sample room has an electric self-heating centrifuge, a sink for washing sampling equipment, storage cabinets, tanks for benzol and solvents, hydrometer wells, and three electronically operated automatic samplers, one for each incoming line. All electrical equipment in the sample room, including the centrifuge, fluorescent lights, heater, and exhaust fan, is explosionproof.

Three gear-type pumps installed at the meter banks continuously circulate oil from the incoming stream through the automatic samplers and back to the line. The sample circulating streams are taken from the center of the pipe on the risers to the strainers, and excess not taken by the samplers is returned to the line about 1 ft. downstream from the point from which it is taken. A fourth gear-type pump continuously circulates a stream through the batch detector on the North Louisiana line.

Alarm functions . . . An alarm-indicator panel located in the gager's office continuously indicates condition of electrical and automatic equipment. Blue or amber lights tell at a glance if the sampler or batch detector pumps are running or shut down, whether or not samplers and batch detector are energized, and whether or not the prover tank pump is running. This pump is manually started and automatically shut down by a capacitance probe device in the prover tank. Red lights on the panel together with an audible alarm indicate high sump level and failure of ruture disks in the relief header. A circular recording chart indicates batch interface arrivals.

Communication facilities include a local city telephone, a telephone to the refinery tank-farm office, direct wire telephone and teletype to the dispatcher's office in Shreveport and teletype to the district office in Brookhaven, Miss., and adjacent pipeline stations on each of the three pipeline systems. All dispatching is done by teletype to provide written records.

While this installation was certainly not the first of its kind, it is probably the largest. It has greatly simplified and streamlined what was previously a very cumbersome and unwieldly operation and has received the wholehearted approval of the operating personnel.

THE AUTHOR

Wallace K. Luse is a mechanical engineer in the general engineering department of Interstate Oil Pipe Line Co., Shreveport. He earned his B.S. degree in mechanical engineering at Louisiana State University in 1938 and joined Interstate's predecessor, Standard Oil Co. of Louisiana, in 1939. His pipeline career was interrupted from 1941 to 1947 when he served in the U. S. Corps of Engineers where he attained the rank of lieutenant colonel. He worked in pipeline research engineering and pipeline design engineering prior to becoming mechanical engineer in 1955. He is a registered mechanical engineer in the State of Louisiana.

1 McNamar-Joy single cylinder, vertical, double acting compressor rated to 100 horsepower, pressures to 1000 psi. Belt-driven with engine of your choice. Vibration on all McNamar-Joy units is virtually eliminated. Approximate weight — 7000 #. Overall dimensions 7' wide by 10' long.

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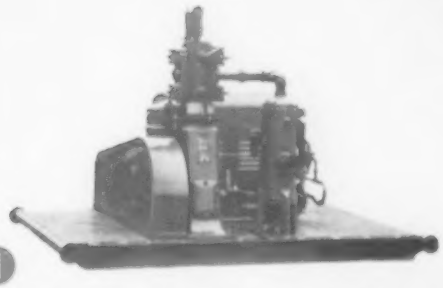

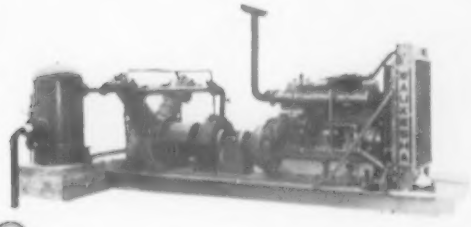

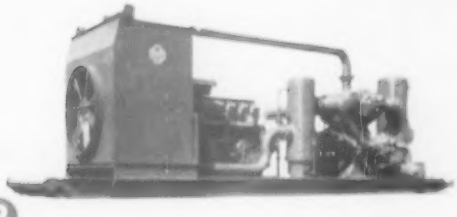

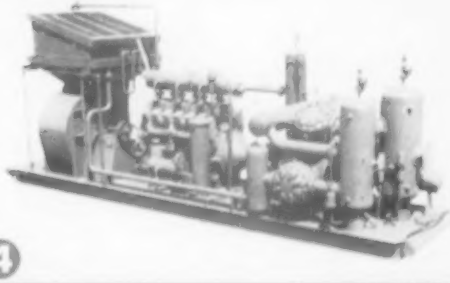

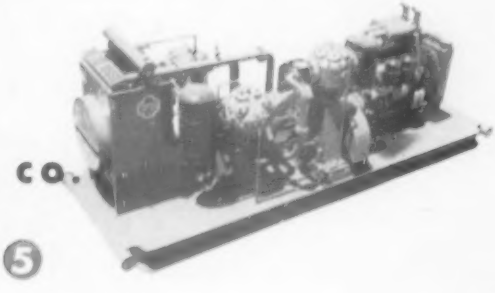

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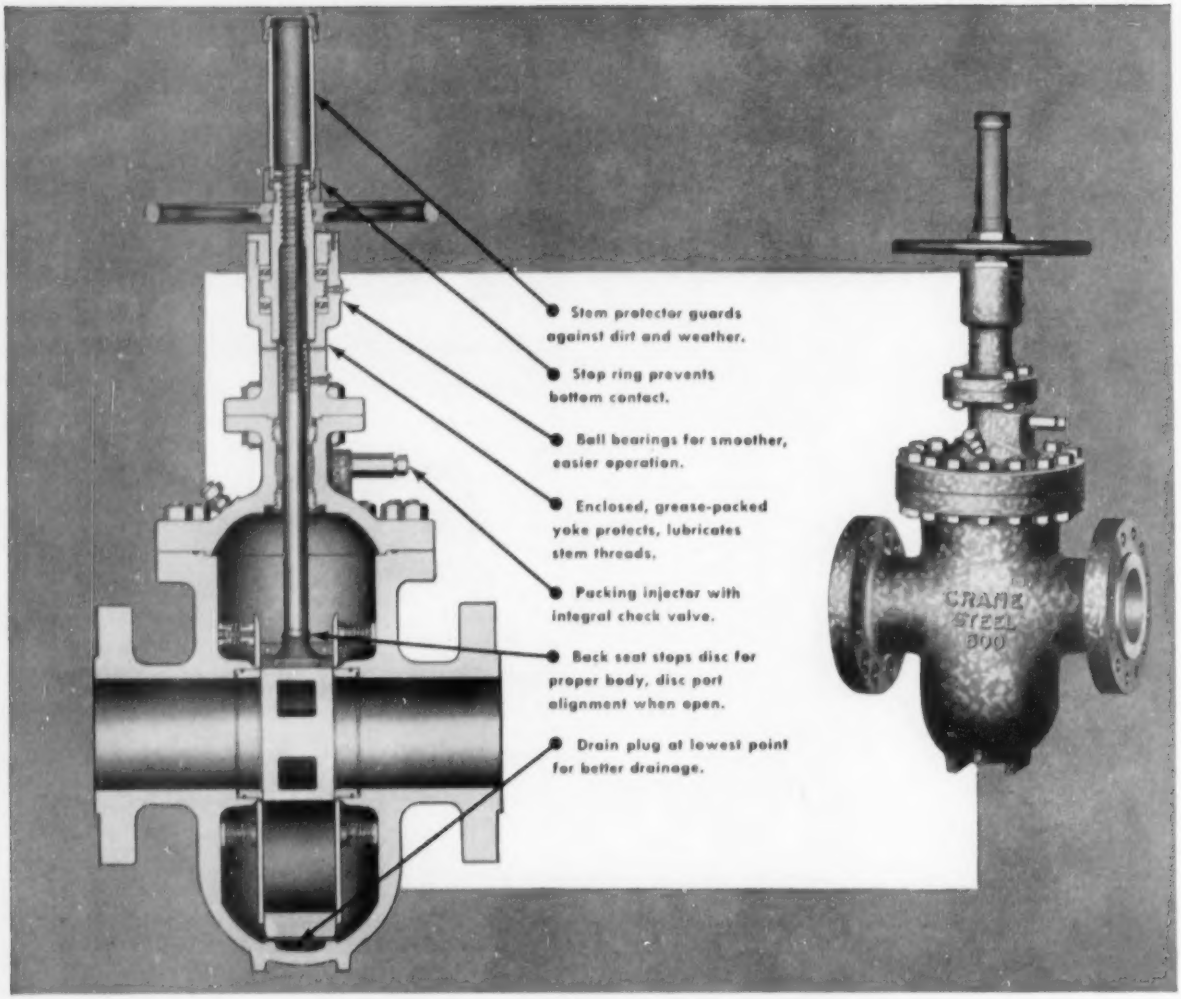
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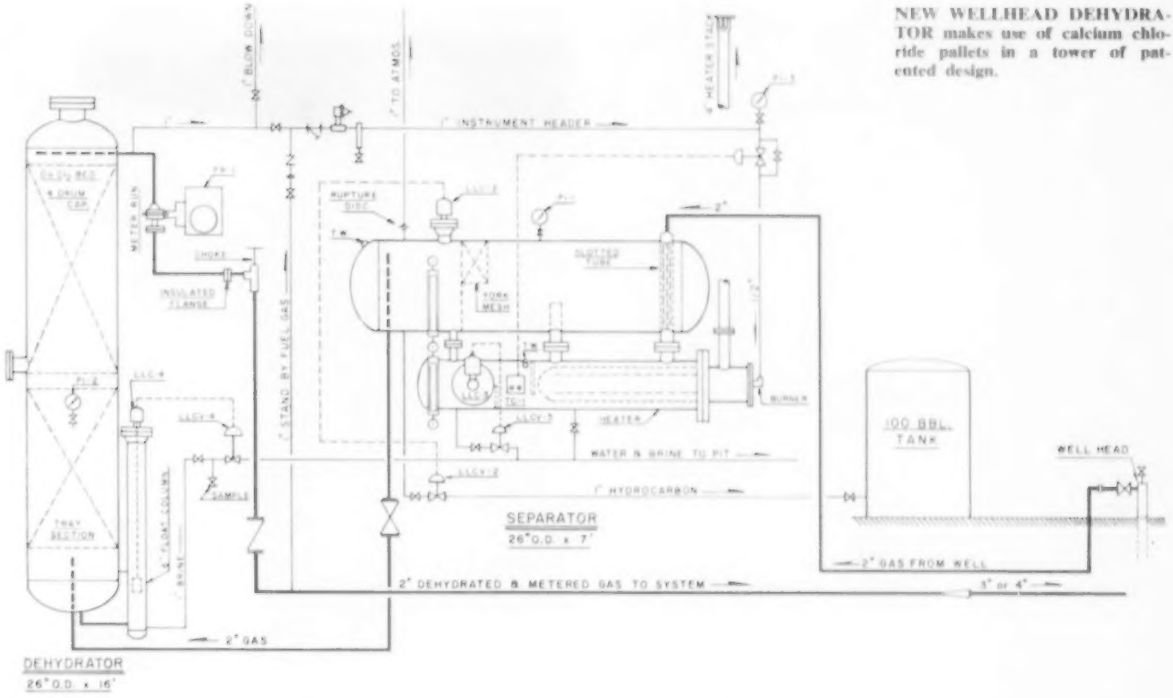


NEW WELLHEAD DEHYDRATOR makes use of calcium chloride pallets in a tower of patented design.

New Unit Triples Dehydration Efficiency

by Howard Walters
Fish Engineering Corp.

A NEW wellhead dehydration unit which removes more than three times the usual amount of water per pound of chemical is now available. Calcium chloride is used as desiccant. The dehydrator has no moving parts and uses no fuel gas in the $CaCl_2$ tower. Aside from reloading the desiccant and changing the charts, no maintenance is required.

The new unit makes use of calcium chloride pellets in a tower of patented design. The tower utilizes the brine formed by the water and calcium chloride as a dehydration agent. Because of new high-efficiency contactor trays, the amount of water removed from the gas runs 3½ to 5 lb. of water per pound of calcium chloride, instead of the usual ratio of 1½ to 1.

Extensive tests in the severe winter temperature of the San Juan basin and Big Piney field in Wyoming have proved the satisfactory operation of the dehydration unit. There were no freeze-ups despite temperatures ranging down to 45° below zero. Dew-point depressions of 75° to 100° F. were produced, without fuel-consuming pumps, heat exchangers, stills, or reconcentrating equipment.

Dehydrator Operation

The gas from the separator passes through the self-circulating trays and is partially stripped of water vapor by contact with the brine, and then passes into the upper bed of highly anhydrous calcium chloride.

The remaining water vapor absorbed directly in the calcium chloride bed is the source of the brine reflux, and since this brine dripping from the upper bed is highly concentrated (1.40 specific gravity), it continuously and automatically maintains the proper concentration of the reflux, eliminating any expensive reconcentration with its subsequent corrosion problems.

The dilute brine leaving the bottom of the column is about 1.15 to 1.20 specific gravity and because of the low cost of the material used, it is considered expendable and run to a nearby drain pit, along with any free water produced by the well.

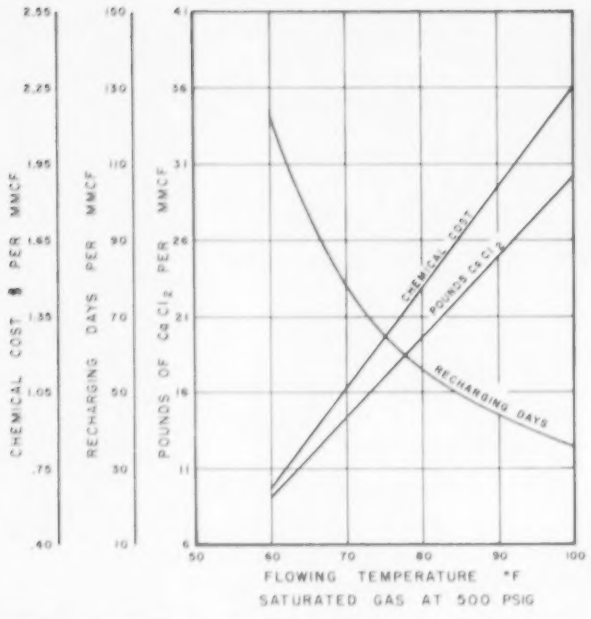
The problem of circulating the brine without circulating pumps was solved by designing a new type of tray which utilizes the flow of gas through a series of jet-action, or gas-lift, nozzles, to pick up and recirculate the brine on each tray. The rate of circulation is controlled by a series of weirs and baffles.

Any small amount of hydrocarbon condensation which may take place in the tower is removed by a series of skimmer baffles, directed into the bottom of the tower, and removed from the column, along with the spent brine, by the liquid-level control.

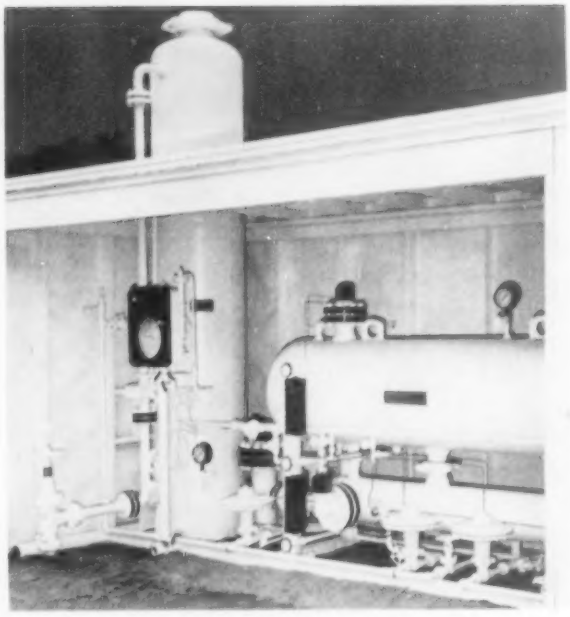
The upper half of the column serves as a storage chamber for the anhydrous calcium chloride, When completely full, it will hold four drums (370 lb. each) of $CaCl_2$. As the calcium chloride is used up, forming the brine, the storage column is lowered; however the efficiency of the unit is not affected until the level falls to a depth of 24 in.

Normally the dehydrator unit is recharged when three drums of calcium chloride have been consumed. It is not necessary to remove the calcium chloride left in the unit at the time of recharging. Recharging is accomplished in approximately 15 to 20 minutes.

Since the unit consumes calcium chloride in direct proportion to the pounds of water vapor contained in the gas at operating temperature and pres-



COST OF MATERIAL, per million cubic feet, at various flow temperatures.



NEW WELLHEAD DEHYDRATOR, ready for installation in the field.

sure, the time of recharging the unit can be accurately forecast.

Horizontal separator . . . An A.S.M.E.-code-designed heater is attached to the bottom of the separator with fast-opening Gralock flanges for easy removal and cleaning. In normal operation, the heater is only required during low-temperature periods to maintain the water in the separators safely above freezing, and is thermostatically controlled at about 50° F.

Strictly speaking, this heater has nothing to do with the dehydration process. In practice, the heater usually operates when ambient temperatures reach 15° F. Under severe winter temperatures, fuel gas for this heater usually runs 2,000 to 3,000 cu. ft. per day. However, the heater is of sufficient capacity to successfully handle wells producing emulsions.

The liquids entering the separator are directed downward into the heater, due to the slotted inlet pipe. This is particularly true of the liquids containing emulsions and is intended to flow the cold, incoming liquids across the heater tube surface to obtain better separation of the hydrocarbons and water.

The separator is equipped with a wire-mesh mist-extractor element for the final removal of entrained liquids from the gas. The water and hydrocarbon levels in the separator and the spent brine level in the dehydrator are maintained by a new type of pneumatic magnetrol, which has proved to be exceptionally reliable for unattended field operation, when operated with the snap-acting dump valves.

Operating and maintenance costs . . . Depending on the temperature of the gas flowing from the unitized separator, the chief operating and maintenance cost is that of replacing the $CaCl_2$, which is used at a rate directly proportional to the amount of water vapor contained in the gas.

Normal consumption of chemical at 550 psi. operating pressure and various flow temperatures is as follows:

Flowing temp. (°F.)	Lb. per $CaCl_2$ per M.M.c.f.	Recharging interval, days per M.M.c.f. per day	Chemical cost $ per M.M.c.f.
60	9.0	123	0.6750
70	14.2	78	1.0692
80	19.7	56	1.4637
90	25.0	44	1.8575
100	30.2	36	2.2713

Fish Engineering Corp. is now producing four models of these units:

Model No.—	Capacity, M.M.c.f. per day	Designed w.p.	Hydrostatic test pressure
A-4-600	2,500	990	1,500
B-4-600	5,000	990	1,500
C-4-300	2,500	660	1,000
D-4-300	5,000	660	1,000

Corrosion . . . All vessels in the unit are designed with code corrosion allowance and since the unit operates at wellhead pressure, this will ordinarily eliminate the presence of free oxygen to promote corrosion. Due to the preferential affinity of the water vapor to the calcium chloride, the destructive dilute acids formed normally in the presence of H_2S or CO_2 will not be present.

Weather protection . . . The entire unit is enclosed in a winterized structure with only the fire box on the separator-heater, the top of the vent stack and the loading nozzle of the tower exposed to ambient temperatures.

Maintenance . . . The unit was designed for ease of maintenance. The gas-fired tubular heater can be removed from the outside of the winterized housing by simply unbolting one flange. The entire heater can be disconnected in seconds by unbolting the quick-make couplings. The entire unit can be steamed out, cleaned, and reassembled in 2 hours. $CaCl_2$ must be added to the dehydrating column at intervals of 36 to 128 days, per million cubic feet per day of gas throughput.

The top of the column has a quick-make coupling which can be opened in a few seconds after pressure has been bled off. $CaCl_2$ can be introduced either by hand or mechanically. Two new truck-mounted regenerating units are now in use servicing Pacific Northwest Pipeline wells in the San Juan basin. A boom conveyor tube mounted on the truck can be spotted over the tower delivering $CaCl_2$ quickly and with minimum loss. In this operation regeneration is completely mechanical.

Installation . . . The unit is entirely skid-mounted. All piping, instruments, and controls are preassembled and shop-tested. The unit requires no foundation on normal bearing soil. The winterized housing is made of prefabricated bolted sections, and provided with adequate flashing to seal all openings.

Youngstown's "big 5"

HELP SOLVE YOUR OIL OR GAS LINE PROBLEMS, WHEREVER YOU ARE

Here are the "Big 5" reasons why Youngstown Electric Weld Line Pipe is your best buy:

1. It bends readily
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3. Line up characteristics are excellent
4. Weldability is outstanding
5. Long lengths save you time and trouble

It's no secret that installation crews prefer Youngstown Electric Weld Line Pipe for its easy line-up qualities. Good line-up is a direct result of the extra care that goes into its manufacture. To achieve the optimum in roundness, each length of Youngstown Pipe is placed in an hydrostatic expander, here, internal water pressure forces the pipe out against the solid steel walls of the mantle. The diameter of the pipe is thereby increased to a uniformly accurate size. Every length conforms to specifications—ends are truly round, uniform in wall thickness, squarely cut and properly beveled for welding. These excellent line-up characteristics are more evidence that it pays to specify Youngstown Electric Weld line pipe.

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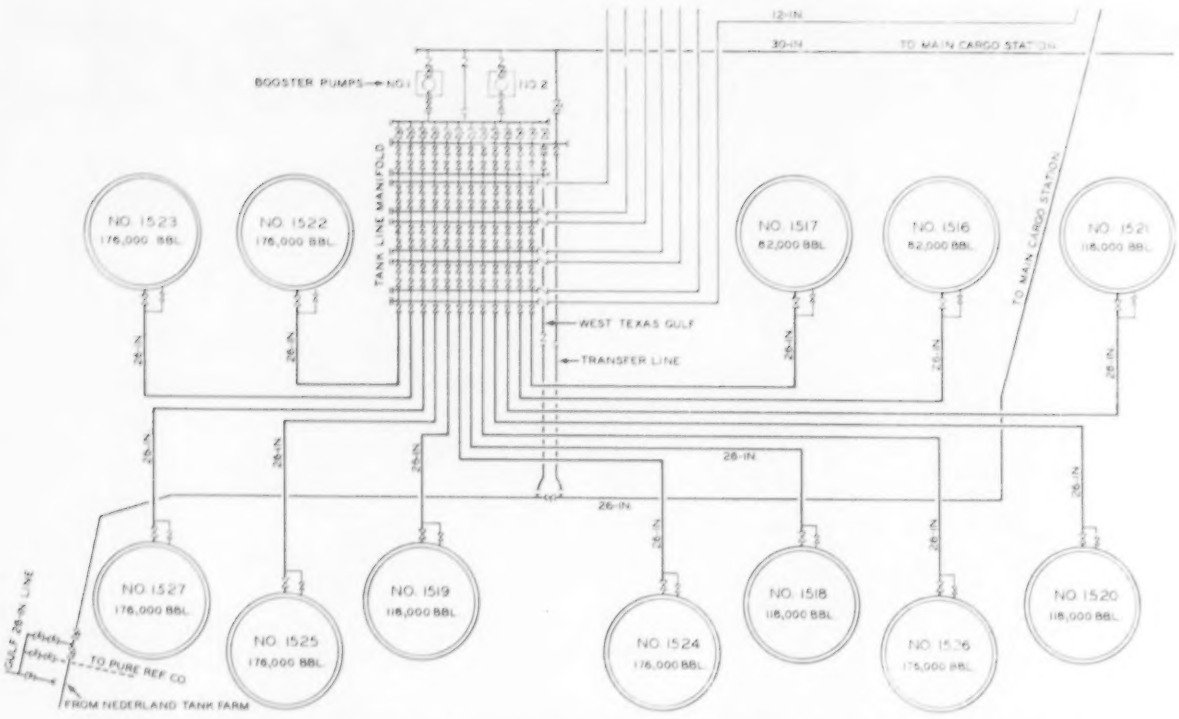


SCHEMATIC OF THE NEW PIPING and storage systems in Sun Oil's Gulf Coast terminal near Beaumont. Fig. 1.

New Facilities Speed Tanker Loading

. . . and streamline operations at Sun's Beaumont terminal

R. G. Deering
Associate Pipeline Editor

A MODERNIZATION and addition of crude-oil storage and tanker-loading facilities by Sun Oil Co. at its Sun Station Terminal near Beaumont, Tex., is nearing completion.

Six new 176,000-bbl. tanks are being built with future locations and plans for five more of the same size to be added if and when they are needed. These are floating-roof tanks, each 56 ft. high. This work is part of an over-all plan of expansion for these facilities. Large-diameter tank lines, in a single-line system, connect the tanks to a central manifold. Two 10,000-bbl. per hour booster pumps at the new manifold furnish suction to three main cargo loading pumps through a 30-in. line. Operational efficiency is added by remote control of booster pumps and key valves in the manifold and station piping from the main cargo station control room. Loading rates from the old part of the tank farm serviced by these new facilities were increased substantially allowing a more flexible storage situation.

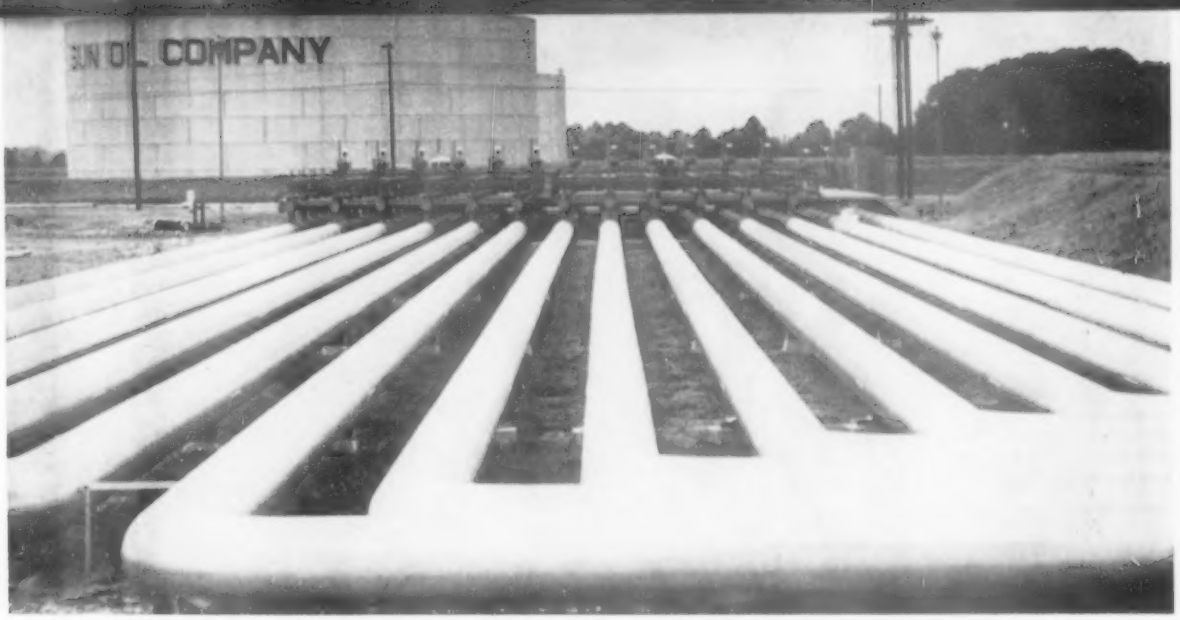
The revamped system allows maximum tanker loading rates of 22,300 bbl. per hour as compared to 18,000 bbl. per hour prior to the revision. This provided an average 19 per cent decrease in tanker-loading time on the tankers with larger loading capacities. Considerable advantage was gained on all tanker-loading rates. An ultimate loading rate of 30,000 bbl. per hour is possible when it becomes practicable.

Ten incoming lines . . . The tank farm is a terminus of 10 pipelines with receiving capacities up to 12,200 bbl. per hour. Barge-unloading facilities for crudes, and tank-car and tank-truck unloading positions for products only are a part of the installation. Six to 10 grades of crude oil come to the farm from fields in West Texas, Louisiana, and the Gulf Coast. Extensive crude blendings with other crudes and butane are made for tanker shipments.

The terminal, located on the Neches River, loads approximately 2,500,000 bbl. aboard tankers each month, most of which is shipped to Sun's Marcus Hook refinery. Crude is also pumped north to Sun's Toledo and Sarnia, Ont., refineries. This operation is handled by a high-pressure pumping unit at the main cargo station.

Before the latest revisions were made, Sun's storage facilities in the immediate area consisted of 22 tanks of 1,843,000-bbl. capacity at Sun station, 13 tanks of 715,000-bbl. capacity at the Nederland tank farm nearby, and 35 tanks of 1,925,000 - bbl. capacity which was leased storage located about 5 miles away. This totaled 4,483,000 bbl. of storage. With completion of the six 176,000-bbl. tanks now being constructed, the 35 leased tanks will be given up. The total storage then will be 3,614,000 bbl. with plans to increase this figure with demand.

Crude movements on the tank farm are controlled from a modern control



MAIN PIPE ALLEY and central manifold showing the 26 in. combination suction and fill lines. Fig. 2.

center at the main cargo station located between the new central manifold and the loading dock. This station has a control console with a single-line graphic system showing piping equipment which effect loading, receiving, and transfer operations. Remote-controlled valves are shown in the schematic piping diagram, Fig. 1, along with their push buttons and indicating lights. Push-button stations are adjacent to respective symbols of their pumping units.

Automatic, remote-reading tank gages provide ready access to oil-volume information on all tanks on the Sun station farm and those of the Nederland farm. Three 8,000-bbl. per hour main cargo pumps load oil from this location through two 16-in. lines to dock positions. These two lines are equipped with automatic samplers of the proportional-to-flow type. A main line unit also located at this point handles approximately 1,600 bbl. per hour for supplementing north-bound pipeline movements. A booster pump located centrally among tanks for lower-gravity crude-oil service is operated from this air-conditioned control room, as are the two new booster pumps located at the central manifold. A modern sample room is a part of the main control building.

Barge unloading is handled from a barge dock operated separately but in conjunction with the tank farm.

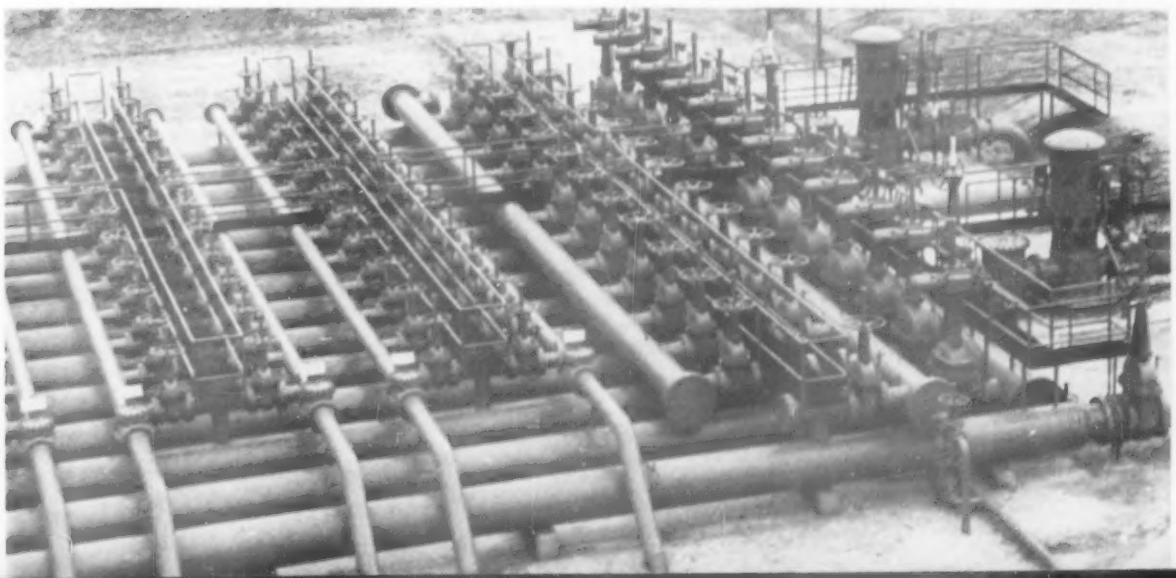
Expensive dock time . . . Reducing the loading time of tankers was the prime economic justification for the large tank lines and booster units. The complete analysis included such real costs as labor, crude costs, and losses involved, amortization of facilities, and power. These combined made the project attractive financially and reflected the need of additional capacities being provided for future operations. New storage will provide even more attractive loading rates with additional head being made available by tank height, location, and the new piping installation.

The economics by which the new storage was provided weighed costs of equivalent leased storage, filling and breathing losses, power costs for transfers, labor costs involved, additional pumping facilities amortization, communications, etc. Both cone-roof and floating-roof tanks were compared with the floating roof being considerably more attractive.

Tank-Farm Pipeline System

The piping system within the Sun station farm formerly consisted of a fill-line and suction-line system with laterals servicing individual tanks. Crude movements within the farm were complex with displacements and isola-

MANIFOLD PIPING showing 10 and 20-in. headers, and the 30-in. suction barrel. Fig. 3.



tion of tanks during operations being the major objections to the system.

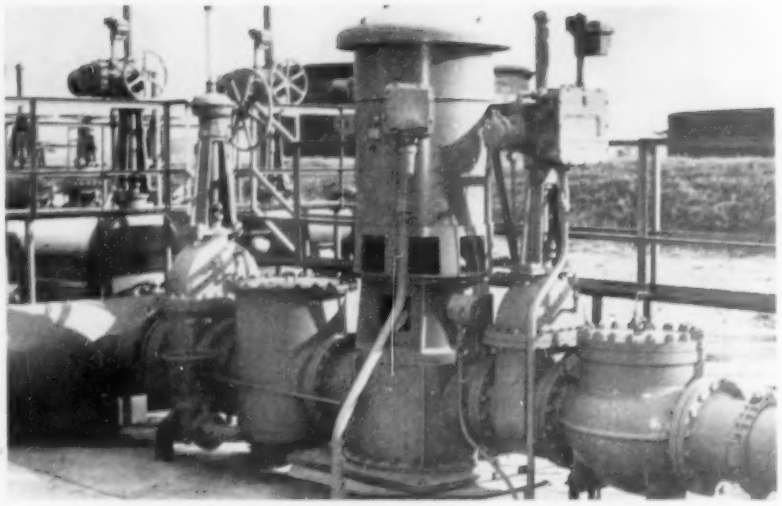
The new piping system, Fig. 2, is composed of individual 26-in. combination suction and fill lines servicing each tank. These are manifolded into the 30-in. booster suction barrel with an individual drop from headers to each incoming pipeline, and a transfer header. The valves on each tank line are motor operated at the suction barrel for ease in lining up the manifold for a remote-loading operation. The piping system is entirely aboveground giving a complete picture of the various operations by a visual inspection. The labor-saving feature of this manifolding is one of the finer points of the installation as is the virtual elimination of displacements.

Line sizing . . . The manifold's location resulted from an extensive engineering study of the present operational conditions in conjunction with provisions being planned for long range expansion of the tank farm. Tank-line sizing came as a result of an engineering study in which all lines were sized after having determined that operational flexibility would allow loading to take place from two tanks at the same time. From this point the critical crude handled at the farm with maximum viscosities, gravities, and vapor pressures were used to weigh power-time elements against initial costs and amortization.

Minor variations in line sizing between the more distant and the nearer tanks led to standardizing on 26-in. pipe throughout the system for reasons of maintenance and symmetry. Design capacities were 30,000 bbl. per hour through two 26-in. lines from a 20-ft. head down to a 1-ft. head. Tank piping is all aboveground, mounted on concrete piers for a controlled expansion by rollers, expansion joints, and anchors. Valve, riser, header, barrel, and bypass sizes were determined by economic analysis balancing power costs with amortization costs. Tank-line block gates on the suction barrel are motor operated with integral-starter operators. Other key valves in the manifold piping are motor operated, some of these being remotely controlled from the cargo station.

The inclusion of the six existing tanks in the new central manifold was justified primarily by reducing displacements, and because of excessive power costs and poor suction characteristics. This then fell in line with the over-all planning scheme. The manifold is shown in Fig. 3.

Boosters . . . Two large vertical type booster pumps were installed at the central manifold for insuring adequate suction pressures at the main cargo station. This, in addition to increasing station capacity, reduced the number of tanks formerly required to fill the main cargo pumps. Due to former line size restrictions, a constant transfer procedure was necessary to line up tanks near the cargo station for loadings. This transfer problem has been solved.



VERTICAL BOOSTER PUMPS are rated at 10,000 bbl. per hour. Fig. 4.

These pumps, 16 by 8-in. vertical, can type, single stage, are rated at 10,000 bbl. per hour at 1,200 r.p.m. and 50 ft. of head. They are powered by 125-hp. totally enclosed, fan-cooled motors. By addition of stages, provided for in can structure, increasing unit horsepower, and the addition of a third similar unit, cargoes can be loaded from this point through revised lines to dock positions at 30,000 bbl. per hour.

Original design criterion was for the booster units to be used for loading only during the lower 20 ft. of tank head, taking full advantage of the full 56-ft. heads. It has since been determined that it is economical for their use during the entire loading operation where tankers offer no restriction to the added capacity. The vertical type of pumps have proved flexible in transfers from nearby Nederland tank farm operating with discharge pressures up to 20 psi. and vacuum of 15-19 in. of mercury.

Control of this pumping equipment is handled remotely from the cargo station. The two discharge valves, pump-motor amperage, and booster discharge pressures are remote features of the operation. Remoting is by sequential tone signaling equipment operating through overhead cables. Balanced mechanical seals are installed on these units. Fig. 4 shows the pump installation.

Tank Design

The new 176,000-bbl. tanks are of the floating-roof type, using double-deck roofs. They are 56 ft. in height with a diameter of 150 ft. Bottoms are cone shaped with slopes out and downward to the shell. Lengthy studies were made in order to justify the floating-roof over the more conventional cone-roof tanks. Breathing and filling losses were determining factors in their choice, with initial costs, foundations, venting problems, maintenance, etc., being considered. The height provided desirable suction pressures, and their capacity was determined by the economics.

The tank height is rather unusual in itself, having presented out-of-the-ordinary foundation problems. The design, after size core analysis, was for the removal of soil to a depth of approximately 3 to 4 ft. and for a diameter of 174 ft., to reach a stratum of sufficient bearing capacity. The soil removed was replaced with a sand admixture. This admixture was placed in layers each being compacted thoroughly to obtain a 3,500-lb. per square foot bearing. This compares to the 1,500-lb. per square foot native soil. The tank shells set on reinforced-concrete rings 18 in. wide by 12 in. deep. This ring was designed primarily as a retainer ring for the foundation.

Cathodic protection for the new storage and piping was added in balance with the remainder of the farm. This required two 20-volt, 100-amp. selenium rectifiers with graphite anode ground beds. The remainder of the system consists of one 40, one 80, and one 100-amp. units similar to the two new ones.

TWO TRANE Fluid Coolers are used at this refined products pumping station at Vicksburg, Michigan. Model EC at left (horizontal air flow) cools hydraulic oil. Model GC at right (verticle air flow) cools jacket coolant, which in turn cools lube oil for Nordberg 2650 hp Diesel. Station is part of a system operated by Shell Oil Company as agent for Wolverine Pipe Line Company.

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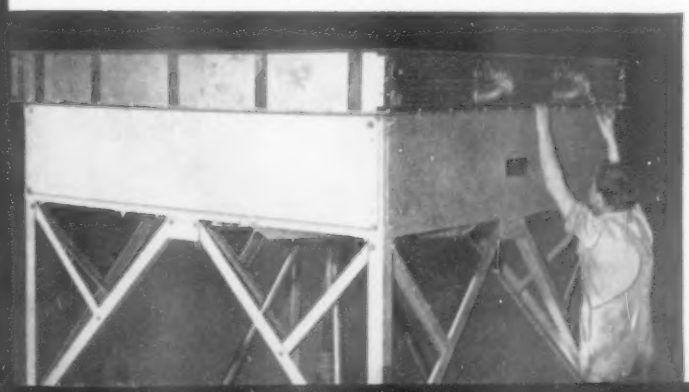

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Batching a High-Viscosity Crude Oil

. . . in a big-inch pipeline

After a 2-year testing program, Interprovincial started batching heavy Saskatchewan crude in with its regular light Alberta crude. The big result has been a reduction in throughput capacity when the batches are in the line and a compounding of dispatcher's problems. But the conclusion is that such crudes can be handled by conventional equipment with but a small increase in tariff rates.

by Paul H. Buckland
Interprovincial Pipe Line Co.

World's Longest Crude-Oil Line

Interprovincial Pipe Line Co. and its subsidiary, Lakehead Pipe Line Co., Inc., own and operate a 1,773.4-mile crude-oil pipeline which runs from the Edmonton, Alta., area to Sarnia, Ont. This line is the longest crude-oil line in the world and presently has sufficient capacity to handle 212,000 bbl. per day from Alberta, and 50,000 bbl. per day from Saskatchewan and Manitoba.

Deliveries are made along the route of the line to refineries in Saskatchewan, Manitoba, Minnesota, Wisconsin, Michigan, and at Sarnia. The original line could handle 150,000 bbl. per day out of Alberta and terminated at the head of Lake Superior, 1,098.3 miles from Edmonton. The present system is being currently expanded by a stepwise program which will ultimately provide sufficient capacity to handle over 400,000 bbl. per day from the three provinces of western Canada.

The expansion program consists of the addition of a second line to the original line and a 644.4-mile extension from Lake Superior to Sarnia, Ont. The extension was completed in 1953 while sections of the second line have been progressively constructed since 1953 in the form of main-line loops.

SINCE May 1955 Interprovincial Pipe Line Co. has been handling batches of heavy Saskatchewan crude oil along with its regular tenders of light Alberta crude. Before handling the oil, Interprovincial made a 2-year study to find possible effects of the heavy oil on its normal operations.

It found that the heavy crude could be pumped by conventional equipment in a line designed to handle only light oil. The heavy crude has a viscosity of 4,700 S.U.s. at 20° F. At the lowest line temperature, 35° F., its viscosity is still about 2,000 S.U.s. At this figure, tests showed that the line pumping rate would be lowered by at least ¾ bbl. for each barrel in the heavy crude batch.

All of the Alberta crude oil shipped in this line, as well as most of the Saskatchewan and Manitoba crude, is light gravity-low viscosity crude. The gravities range from 32° to 39° A.P.I., and the viscosities at the average pumping temperature of 50° F. range from about 48 to 104 S.U.s. However, since May 2, 1955, the company has been receiving Fosterton, a medium gravity-high viscosity crude at its Regina, Sask., pumping station. This crude is a blend of crudes from Fosterton, Cantuar, Success, and Battrum fields in southwestern Saskatchewan. It has a gravity of about 22° A.P.I. and a viscosity which ranges from 540 S.U.s. at 65° F. to 4,700 S.U.s. at 20° F.

This crude has been shipped from Regina to Clearbrook, Minn., since June 23, 1955. Pumping rates of this crude have exceeded 200,000 bbl. per day and it has been pumped from tankage at temperatures as low as 20° F. Few operating difficulties occurred during the first year of operation which had not been anticipated before the initial receipt of the crude. However, a thorough investigation was made over a period of about 2 years before the initial receipts were accepted.

The problems of pumping this crude were complicated by the fact that it had to be batched in the same line as the light gravity crudes, had to be pumped by the existing diesel-driven centrifugal pumps, and had to be transported through main-line loops. These loops consist of sections of 24 and 26-in. pipe ranging from 35.4 to 71.9 miles in length which parallel the original 16 and 18-in. pipeline.

This article covers two stages of the investigation of this Fosterton crude as follows:

1. Preliminary calculations and model testing which preceded the Fosterton shipments.

2. Tests under actual operating conditions which have been made since the initial Fosterton shipments to check the preliminary calculations and model testing.

Preliminary Calculations and Testing

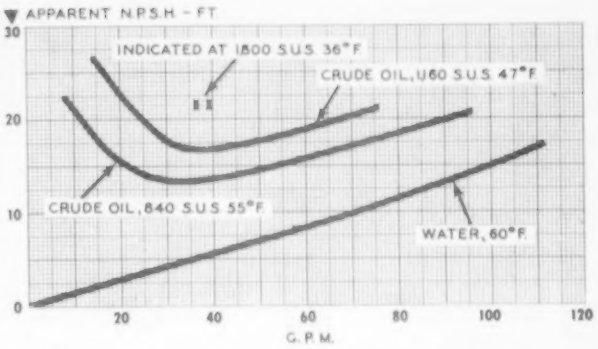
In February 1953, viscosity tests were made on a McMichael viscometer (rotational type) at University of Alberta, results of which have been found in practice to be very reliable. As a further check of the viscosity, the Fosterton crude was tested in a pipeline model at University of Alberta during February 1954.

Based on the viscosity data, calculations were made to determine the effect of the crude on the trunk-line capacities. The results showed that every barrel of Fosterton pumped as a batch would reduce the capacity of a normal light-gravity crude line by about ¾ bbl. For example, if 50,000 bbl. of Fosterton crude was batched through a given line with a capacity of 120,000 bbl. per day of light crude, this capacity would be reduced by 37,500 bbl. per day to 82,500 bbl. per day.

Further, it was found that main-line loops magnified this capacity loss to about 2 bbl. of light-crude capacity lost for every barrel of Fosterton pumped. That is, 20,000 bbl. per day of Fosterton batched in a looped system would reduce the capacity by 40,000 bbl. per day, or from 200,000 bbl. per day to 160,000 bbl. per day.

Pump efficiency lowered . . . Viscosity-correction data as presented in the tenth edition of the Standards of the Hydraulic Institute indicated that the hydraulic horsepower available from the existing pumping equipment would be seriously reduced while the Fosterton batch was being pumped through a pump station. The data indicated that the efficiency of the existing centrifugal pumps would be reduced from about 85 per cent to about 60 per cent when pumping Fosterton at 35° F. A test

MODEL PIPELINE set up at University of Alberta to test the cold-weather characteristics of the heavy crude oil. Fig. 1.



APPARENT net positive suction head required by the test pump increased as viscosity of fluid handled went up. Fig. 2.

under actual operating conditions in the field has shown these data to be reliable.

Tests up to that time had indicated that the Fosterton crude could be pumped economically through a trunk line and with centrifugal pumps. Minimum pipeline temperatures experienced with other crudes up to that time were about 35° F. This temperature would reflect a crude viscosity of about 2,000 S.U.s. However, much lower temperatures had been recorded as low as 20° F. It had been found that once the crudes reached the station, they were heated sufficiently in the engine-cooling system so that the resultant main-line temperature was about 35° F. Thus, doubt still lingered as to whether the Fosterton crude could be drawn out of crude storage at 20° F. with a viscosity of 4,700 S.U.s.

Buttery crude at 10° F. . . . For this reason, another test model was set up out-of-doors at University of Alberta in March 1954. This model, shown in Fig. 1, consisted of a 150-gal. tank from which crude was drawn through a 3-in. suction line by a centrifugal pump. The crude was cooled not only by the weather, but by a cooling coil installed in the tank. The tests indicated that the oil would move freely at temperatures as low as about 10° F., at which point the crude appeared to be as stiff as soft butter.

Tests on the model pump indicated that the net positive suction head (N.P.S.H.) required above the crude's vapor pressure increased as the viscosity as shown in Fig. 2. As the literature on this subject is meager, care was taken in the selection of the prototype tank booster pumps. The head, capacity, and efficiency of the model pump were reduced, but the data did not check too closely with those presented in the Standards of the Hydraulic Institute. Test results were successful enough, however, to indicate that the viscosity-correction data were conservative. Perhaps one reason the data obtained from the model did not check too well is that the unit operated well below the low-capacity range of the Hydraulic Institute data.

By this time sufficient test data had been accumulated so that an agreement could be made with the shipper to transport the crude from Regina to Clearbrook in volumes up to 20,000 bbl. per day.

As a matter of general interest, it might be wise to point out that all tests conducted at University of Alberta, both preliminary and those recently completed, have indicated that Fosterton crude is Newtonian over the anticipated range of operating temperatures (i.e., 35° to 65° F.). However, at about 35° F. it does tend to exhibit non-Newtonian characteristics of a pseudo-plastic nature. This tendency is very slight, and is not a magnitude to effect pipeline capacities.

Other western Canada crudes have been found to be non-Newtonian throughout the anticipated range of operating temperatures. Such crudes are very difficult to analyze when determining viscosities; and therefore, it is very difficult to predict their pipeline performance. If Fosterton crude had been non-Newtonian to an appreciable degree, it would have restricted pipeline capacities much more than it does.

Tests Under Operating Conditions

As expected from the preliminary tests and calculations, tests under actual operating conditions are very difficult to analyze. The reason is that as the Fosterton batch moves in the line, it moves into and out of looped sections. Thus, if the main-line discharge and suction pressures are held constant, the rate of flow will vary continuously. Conversely, if the rate of flow is held constant, the discharge pressure varies continuously.

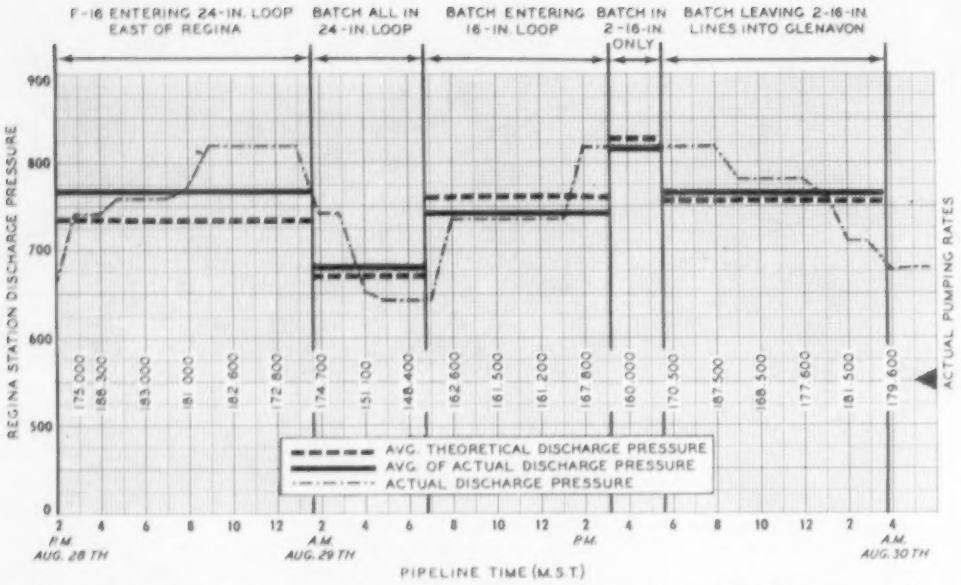
No formal test has been made to check this condition, but data recorded by the dispatching department during the normal course of operations have been checked with the theoretical calculations, and in all cases the data have agreed very well. The results of one check are shown by Fig. 3 which shows the discharge pressure at Regina station as a Fosterton crude batch of 88,426 bbl. (F-16) moved from the Regina to the Glenavon (67 miles downstream from Regina) pumping station.

The actual pressures are shown with a light line, and it can be seen that they vary considerably over the 38-hour period, from 640 to 820 psi., and flow rates varied from 148,400 to 187,500 bbl. per day. The heavy lines compare the average pressure for each progressive step in the movement of the batch with the discharge pressure as calculated, and it can be seen that there is reasonable agreement. However, the dispatching of the batches complicates the operation and makes the determination of main-line capacity extremely complicated.

A detailed examination of this graph illustrates one of the dispatching problems. At around 4 a.m. on August 29, 1955, the discharge pressure fell to about 650 psi. with a resultant drop in throughput from 174,700 to 151,100 bbl. per day. Such a pressure drop is normal to this operation as the operating personnel will intentionally lower the throughput in anticipation of a

THE AUTHOR

Paul H. Buckland, head of the economic and special assignments section of the engineering department, Interprovincial Pipe Line Co., Edmonton, Alta., has been with that company since May 1949. He has been working on various hydraulic and economic problems since joining Interprovincial. He was born and raised in Chatham, Ont., and received his bachelor of applied science degree in mechanical engineering in 1949 from University of Toronto.



CURVES SHOWING ACTUAL and theoretical discharge pressures as Fosterton crude batch moves through line from Regina to Glenavon stations. Fig. 3.

pressure rise which would have occurred when the batch moved into the 16-in. loop had the 174,700-bbl. per day rate been maintained. In addition, excess horsepower must be provided at the stations to maintain the maximum flows. These data were even greater when batching the Fosterton crude.

Actual pumping test . . . A test was conducted in January 1956 which provided the opportunity to check the effect which viscosity has on the head, capacity, and efficiency of the centrifugal pump driven by a 2,040-hp. diesel unit in service at Regina station. The Fosterton crude pumped was at an average temperature of 36.5° F., and the viscosity was in the order of 1,800 S.U.s. Fig. 4 shows the results of the test.

The head, efficiency, and brake-horsepower curves based on the data in the Standards of the Hydraulic Institute are shown by a heavy dashed line and the points obtained from the tests are also shown. It can be seen that data agree very well.

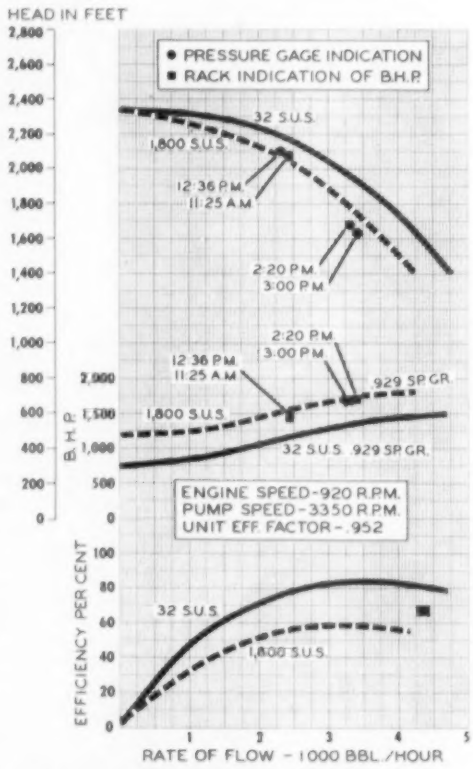
It should be mentioned that during this same test, the Fosterton crude came directly from storage. Initial incoming station temperatures were about 19° to 20° F. and the temperatures gradually rose to about 25° F. 2 hours after the movement was started. It was impossible to assess the data taken during this period because the required rate of flow was being established. The low temperatures encountered initially are believed to be due to the fact that the first crude to the pumps was drawn directly from the sides of the tank, the oil in the interior of the tank was, of course, warmer. However, the significant fact is that oil can be moved by conventional methods even at viscosities as high as 4,700 S.U.s. The total rate of flow from the tank was approximately 160,000 bbl. per day.

Summary

From this discussion, it may be concluded that crudes having a high viscosity can be batched at trunk-line rates in lines originally designed for light crudes. Experience covered by this article, however, has been with crudes in the gravity range above 20° A.P.I. Crudes between 20° and 30° A.P.I. are generally referred to as medium-gravity crudes and such crudes will normally have viscosities ranging from 1,400 to 100 S.U.s. at 50° F.

Results indicate that such crudes can be handled by conventional methods even when the mainline temperatures are as low as 35° F. However, a pipeline company must always maintain a higher investment in its plant than it would if it were pumping a like amount of light-gravity crude. The additional investment is of a magnitude that it can be paid for by the shipper in terms of small tariff additions.

Crudes having gravities below 20° A.P.I. would generally be viscous enough to result in laminar flow at low temperatures even in big-inch pipelines. The resultant high friction factors would necessitate the additional expense of heating stations to maintain the crude at a much lower viscosity.



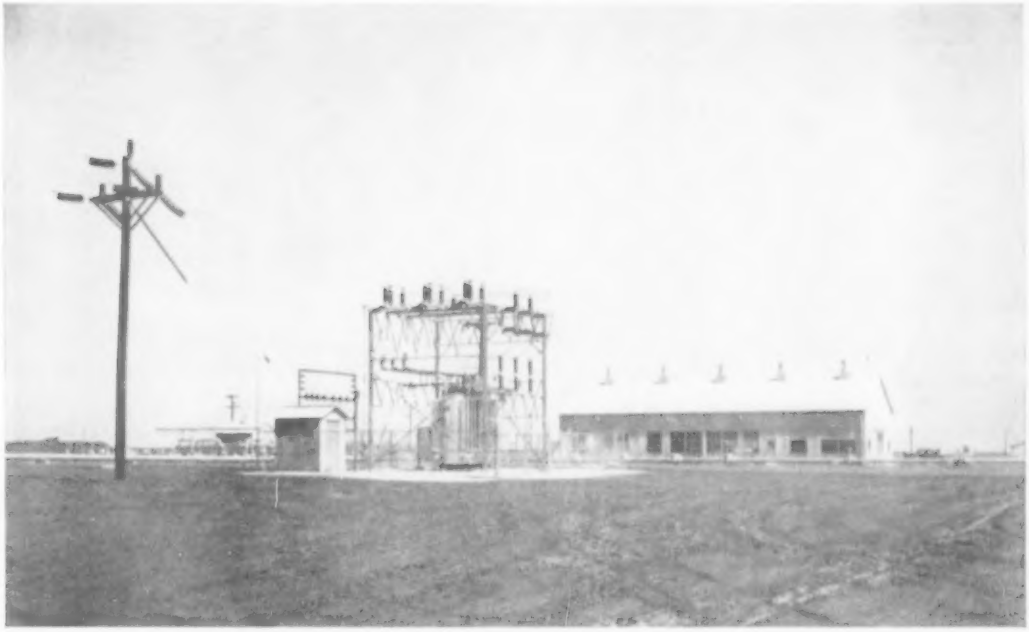
PUMP PERFORMANCE CURVES handling 1,800 S.U.s. crude oil at 36.5° F. Data taken at Regina station while pumping Fosterton crude. Fig. 4.

Acknowledgment

Dr. G. W. Govier, professor of chemical engineering at University of Alberta, Edmonton.

T. K. Fowler and W. E. Boyle, formerly with the engineering department of Interprovincial Pipe Line Co.

Pipelines Transport the Lifeblood of American Industry



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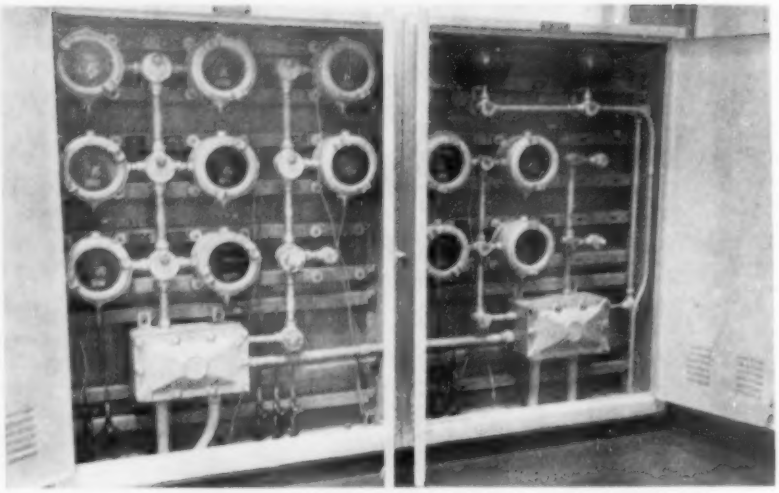
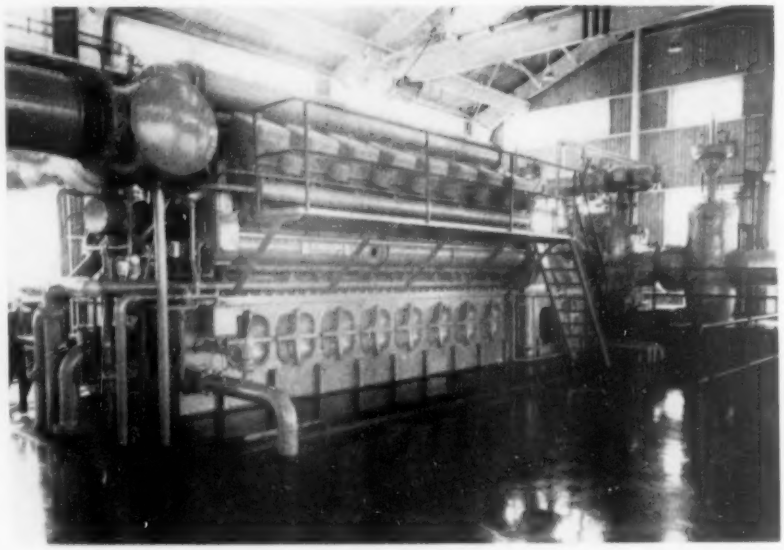
THE PICTURES . . .

TELEMETERING SYSTEM, right, starts in this cabinet containing pressure transmitters and mercury switches for shutdown system.

MAIN UNIT, right, below, is this 3,000-hp. engine which drives centrifugal compressor through 10:1 gear.



Instruments Operate Transco's



Engine-Driven Centrifugal

by Amos F. Williams
Transcontinental Gas Pipe Line Corp.

ONLY two unattended main-line compressor stations are in use in the gas-pipeline industry. One of these is station 23 of Transcontinental Gas Pipe Line Corp. near Houston. In designing the station's control system many new problems occuring only in gas-pipeline operation had to be overcome. The final control system provides local and remote controls and protection plus a separate system which warns of approaching trouble on the compression equipment.

Transcontinental's compressor station No. 23 is located 23 miles north of Houston on the company's main 30-in. natural-gas pipeline. The main compression equipment consists of one 3,000-hp. supercharged, 16-cylinder Nordberg engine driving a DeLaval centrifugal compressor through a 10:1 ratio, stepup gear unit. The engine operates at approximately 470 r.p.m. at rated load. The station was placed in service on December 31, 1955.

One of the considerations in selecting this particular type of equipment was that of anticipated reduced operating costs. To aid in effecting such savings and in recognition of the current trend towards automation, Transco management initially authorized installation of necessary control equipment for semiunattended operation. However, it was specified that the design of such controls proceed in a vein of caution with continuity of service to customers having foremost thought.

Insofar as was known at the time of conception of this station, no other company was operating a major main-line compressor station on any type of unattended basis. It was realized that a solution must be found to several problems which are peculiar only to unattended station operation of gas pipelines.

Objective of Control System

With these thoughts in mind and a full realization of possible mechanical failures with this type of main equipment, it was decided that the controls should accomplish the following objectives:

1. The station to be operated normally with two operators who live in company houses near the premises.

2. Major maintenance such as annual overhauls, etc. to be done by repair crews from neighboring stations 60 miles away.

3. Essential functions of the station to be telemetered to the main dispatching office 23 miles away over leased telephone-wire facilities.

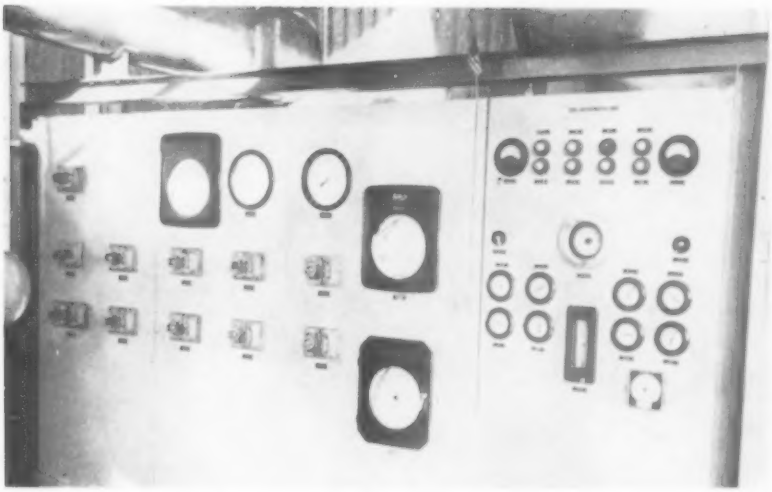
4. Both operators to be permitted to leave the station and houses simultaneously. However, one of the operators to leave word with the dispatcher as to where he can be reached.

5. Equipment to include provisions enabling the dispatcher to shut the station down. No remote-starting facilities to be provided.

6. No automatic sequential startup equipment to be provided. All startup devices to be actuated individually at operator's discretion.

7. All necessary practical equipment to be installed for automatically shutting the station down, on occurrences of abnormal conditions which indicate risk of serious damage or destruction of the equipment.

8. On all automatic shutdowns, control equipment to operate main gas

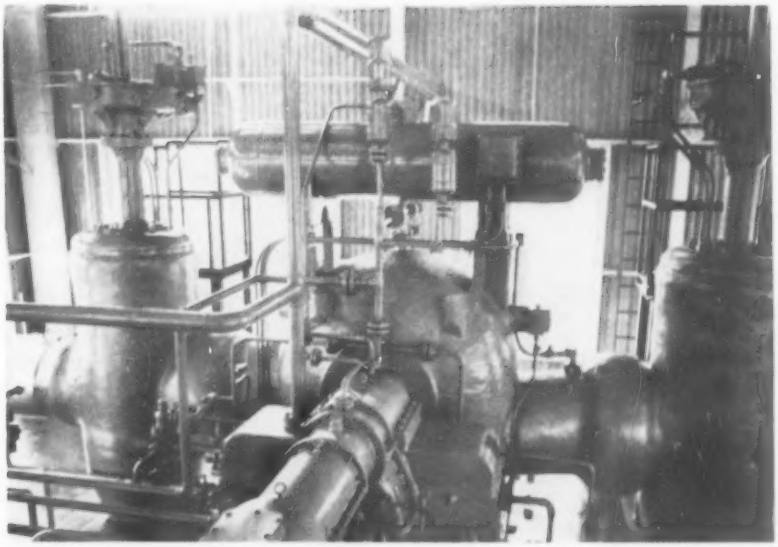


THE PICTURES . . .

CONTROL PANEL at station, left, has push buttons for engines and compressor auxiliary pumps, speed controller, exhaust-temperature indicators, and other engine instruments.

CENTRIFUGAL COMPRESSOR, left, below, is flanked by station suction and discharge valves. Gravity supply tank for seal oil is above unit.

Remote-Controlled



Station Near Houston

A pioneer venture by Transco was building a semiunattended engine-driven centrifugal compressor station. The station is completely instrumented, including remote and local shutdowns plus a separate alarm system which announces approaching trouble.

valves necessary to isolate the station from the main pipeline.

No standby electrical power . . . Three-phase, 480-volt, a.c. electrical power was required to serve many essential auxiliary functions of the engine, gear, and compressor as well as lighting and other miscellaneous equipment about the station. Purchased electrical power from a local utility was found sufficiently reliable for this application. No standby generator was provided; however, means were included to shut down the station automatically in case of purchased-power outages lasting longer than 4 seconds.

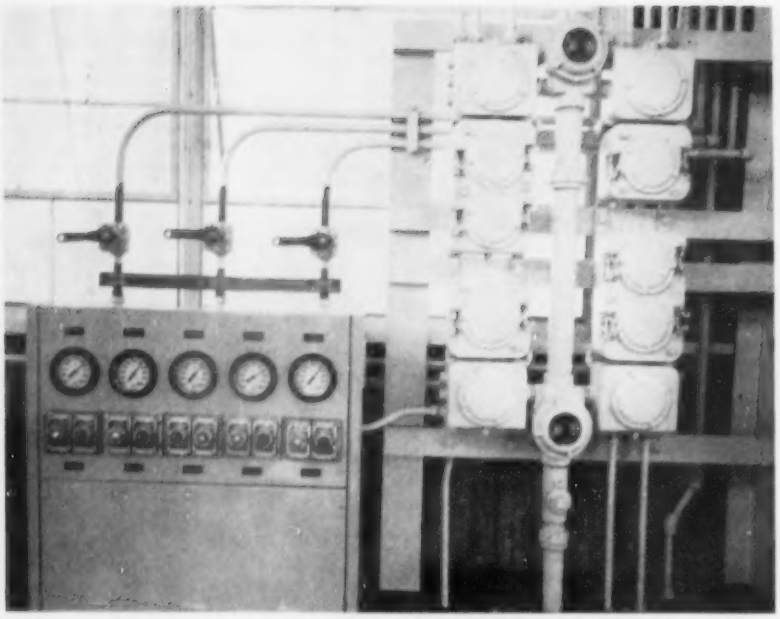
Some form of stored electrical energy was necessary to positively assure that the shutdown and telemetering equipment would be supplied with power during all types of shutdowns. A 48-volt d.c. storage battery was selected which will serve such equipment for a period of 2 hours. It was believed that this would be the maximum time required by the dispatcher to notify one of the operators and order his return to the station.

Automatic Shutdowns

Provisions were included to shut down the station automatically on occurrences of the following abnormal conditions:

1. Excessive jacket-water temperature.
2. Low engine lube-oil pressure.
3. Low jacket-water pressure.
4. Low gear-oil pressure.
5. Low compressor lube-oil pressure.
6. Excessive engine lube-oil temperature.
7. Excessive engine vibration.
8. Excessive compressor vibration.
9. Excessive temperature on upper right gear bearing.
10. Excessive temperature on upper center gear bearing.
11. Excessive temperature on upper left gear bearing.
12. Excessive temperature on lower right gear bearing.
13. Excessive temperature on lower left gear bearing.
14. Excessive pipeline discharge pressure.
15. Low pipeline discharge pressure.
16. Low pipeline suction pressure.
17. Purchased-power system failure longer than 4 seconds.
18. Closing of switch in dispatcher's office.
19. Pressure drop in normally pressurized control system to main-line suction and discharge valves. (This condition could be caused by opening emergency valves located at exits to plant property.)
20. Low level in compressor seal-oil tank.
21. Interruption or fault in communications' circuit to dispatcher's office.
22. Excessive compressor-case temperature.
23. Low control-gas pressure.

A two-position "Local-Dispatch" switch was provided in the station switchboard. It was intended for this switch to remain normally in the "Dispatch" position. By throwing the switch



PANEL with valve-position indicating lights and instruments showing pressures in all main gas-valve control systems.

to the "Local" position all of the above safety features except items 1, 2, 3, 19, and 23 are removed from the shutdown circuit. Excepted items were considered sufficiently critical in nature to warrant immediate shutdown regardless of the Local-Dispatch switch position. It is necessary to throw the switch to the Local position for restarting the engine since devices detecting many of the above abnormal conditions are activated when the engine is down for any reason.

After the engine is brought up to speed and load applied, it is standard procedure to throw the switch to the Dispatch position and restore functions of all the safety features. Provisions were included whereby the dispatcher 23 miles away would always have positive indication of the position of this switch.

The occurrence of any of the above abnormal conditions results in the closing of a contact in the 48-volt, d.c. circuit, energizing a solenoid mounted on the engine. This releases a latched-closed valve and subsequently vents the engine lube-oil pressure control line. The artificial low lube-oil pressure thus created results in the closing of a Fulton Silphon control valve in the fuel gas line to the engine. The station switchboard is equipped with an annunciator which indicates the specific abnormal condition causing the shutdown.

Main-line valve controls . . . The next problem in the control system design was that of closing the main gas-line suction and discharge valves located immediately adjacent to the compressor inlet and outlet flanges.

To detect that the engine has stopped, a centrifugal switch containing one normally closed contact and one normally open contact was selected for mounting on the engine. As the engine speed approached zero the normally closed contact opens to deenergize the shutdown solenoid. The normally open contact closes to energize solenoid valves on gas-turbine operators for the main suction and discharge valves. It also sends a signal to the dispatcher's office that the engine is down. The suction and discharge valves begin closing immediately.

For the opening operation of the block valve a Mercoid differential pressure controller was selected to detect that the station differential pressure has approached zero and to close a contact in a 48-volt, d.c. circuit which energizes a solenoid. This results in the tripping of a latched-closed valve which vents a diaphragm valve. The diaphragm valve then opens to vent a normally pressurized line to the gas-turbine operator on the main-line block valve. The block valve then opens.

At this point the shutdown sequence is complete and the station is completely isolated from the pipeline. In the design it was desired to transmit this information to the dispatcher. It was decided to let this signal be transmitted only when three contacts close in a series circuit. One of the three contacts is closed by the closed limit switch on the suction valve, one by the closed limit switch on the discharge valve, and the other by the open limit switch on the main-line block valve. If any of the three valves fails to operate for any reason the dispatcher will not receive the signal and thus emergency action will be necessary in the pipeline operation.

In arranging the panel to be located in the dispatchers' office minimum essentials were provided in keeping with objectives heretofore mentioned. The panel was designed to provide the following equipment:

1. Indicating recorder giving continuous indication of station suction pressure.

2. Indicating recorder giving continuous indication of station discharge pressure.

DISPATCHER'S control panel has suction and discharge-pressure recorders, other indicators. Glass guard covers shutdown switch.

THE AUTHOR

Amos F. Williams, senior electrical engineer for Transcontinental Gas Pipe Line Corp., came to Transco in 1951 from Fish Pipe Line Construction Corp. where he was doing design work for Texas-Illinois Natural Gas Pipe Line Corp. Previous to working for Fish he served as an electrical engineer with Texas Pipe Line Co. Williams received his B.S. degree in electrical engineering in 1949 from University of Houston. He is a member of the A.I.E.E. and is a registered professional engineer in Texas.

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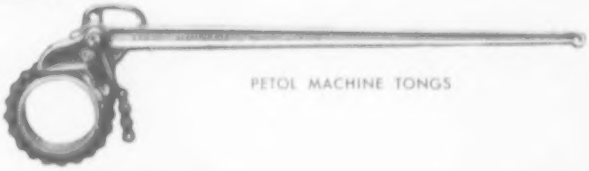

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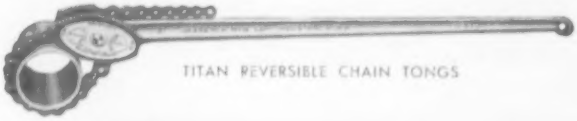

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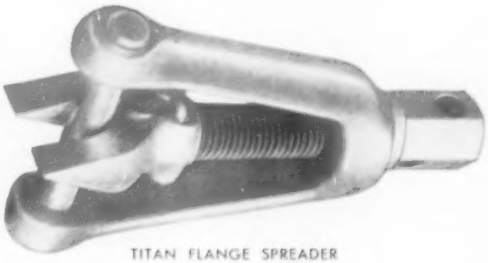

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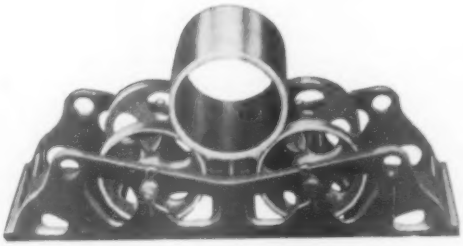

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4. Amber lamp which lights when station shutdown sequence is complete.

5. White lamp which lights when station is placed on Local control.

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7. Alarm bell which alarms when lamp Nos. 3, 4, 5 and 6 illuminate.

8. Alarm-bell silencer switch.

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Alarms for impending trouble . . . In addition to the station automatic shutdown provisions, it was considered very desirable to work out a local alarm system to warn operators of approaching abnormal conditions. Operators are on the premises or in the company houses a large portion of the time. By receiving alarm of approaching abnormal conditions possibly certain station shutdowns can be avoided. The alarm system is served by 110-volt power from the purchased-power facilities. An alarm station was provided in the compressor building, office building, and in each of the two operators' houses. Each alarm station consists of a horn or bell which sounds for 15 seconds and a lamp which illuminates until the condition is cleared.

The following approaching conditions activate the alarm system:

1. Excessive engine lube-oil temperature.
2. Low engine lube-oil pressure.
3. Excessive engine jacket-water temperature.
4. Low jacket-water pressure.
5. Low fuel-gas pressure.
6. Low turbo-oil pressure.
7. Low control-gas pressure.
8. Low gear-oil pressure.
9. Low level in compressor oil-supply tank.
10. Low compressor lube-oil pressure.
11. Low level in seal-oil tank.

As it was necessary to install separate devices to detect the approaching conditions, considerable calibration and field adjustments were made to coordinate such devices properly with devices located in the shutdown system. In addition, the alarm system is activated upon failure of 48-volt, d.c. supply and when the station goes down for any reason. Indicating lamps were provided to enable the operator to determine quickly which approaching condition is causing the alarm.

Seal-oil protection . . . It was considered important to make provisions for maintaining seal-oil pressure or venting the compressor case in the event of purchased-power outage. Upon power failure the seal-oil pumps would stop and the seal-oil tank will maintain a gravity-head supply of oil for about 20 minutes. This supply was considered inadequate in view of the possible 2-hour delay in operators arriving as previously mentioned.

The problem was solved by using three contacts in a series circuit to energize a solenoid and subsequently vent the compressor case. One of the contacts is closed after a 4-second interruption in purchased power. Each of the other two contacts is closed by the closed limit switch in the suction and discharge-valve operators. The circuit thus requires that the purchased power must have failed and that both valves are fully closed before the compressor case is vented.

The interior of the compressor building was classified under Class I, Division I as defined in Article 500 of the National Electric Code. This article deals with hazardous gas concentration probabilities under various conditions. Many of the problems in designing the control system were made much more complex by satisfying all code requirements for the above-mentioned classification.

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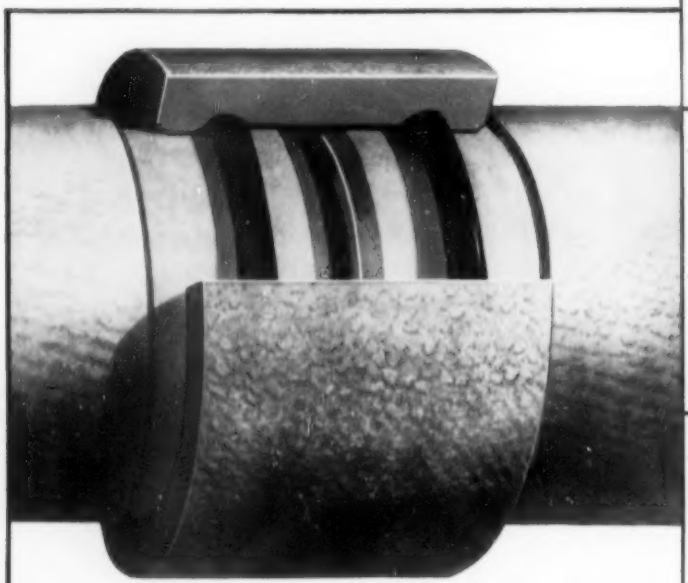

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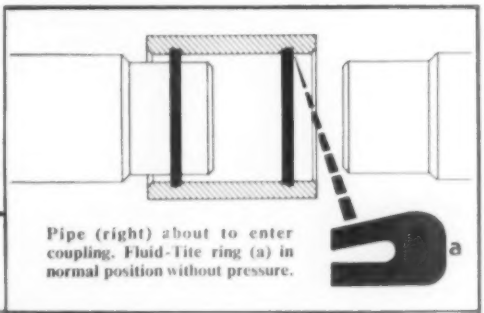
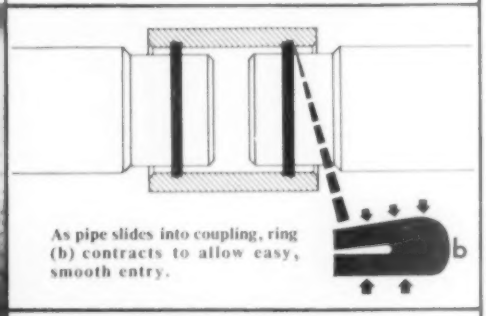
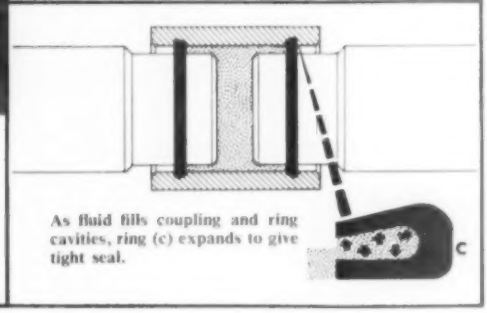


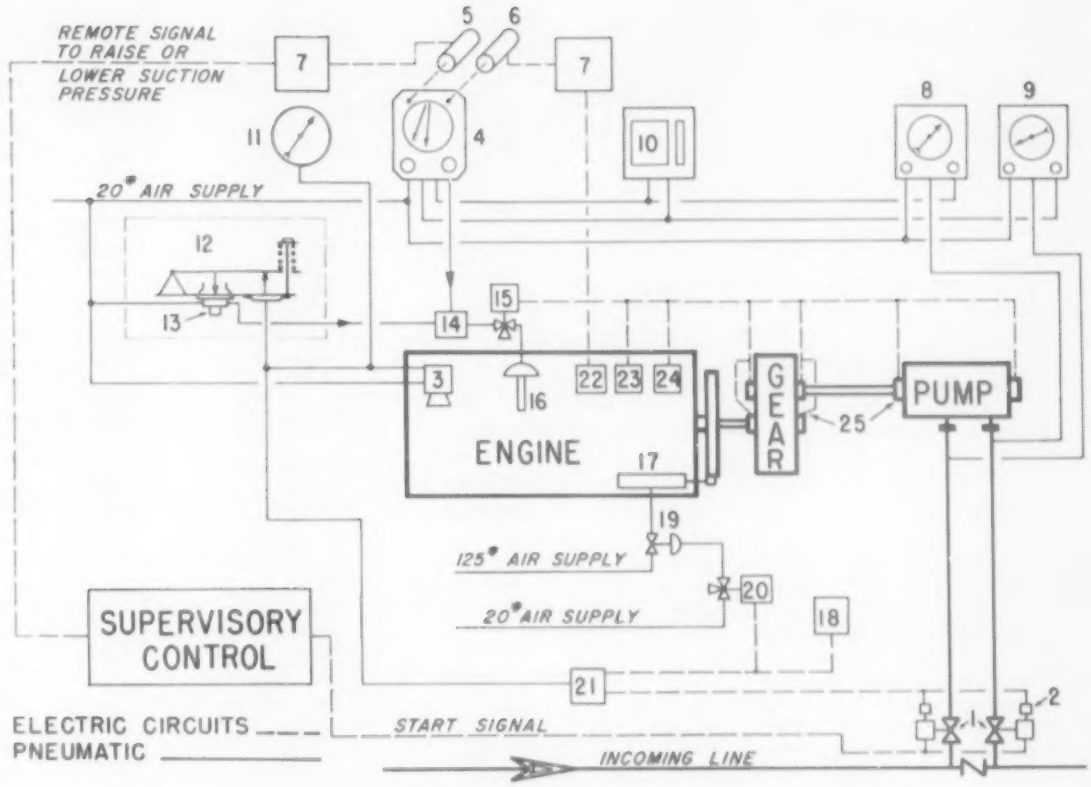
Pipe (right) about to enter coupling. Fluid-Tite ring (a) in normal position without pressure.



As pipe slides into coupling, ring (b) contracts to allow easy, smooth entry.



As fluid fills coupling and ring cavities, ring (c) expands to give tight seal.



LEGEND

1. Motor-operated station valves.
2. Valve limit switches.
3. Pneumatic speed transmitter.
4. Pneumatic pressure controller.
5. Gear-head motor suction control.
6. Gear-head motor-discharge control.
7. Reversing switches.
8. Discharge-pressure transmitter.
9. Suction-pressure transmitter.
10. Strip-chart recorder.
11. Tachometer.
12. Idle-speed controller.
13. Pressure regulator.
14. High-pressure selector valve.
15. Emergency shutdown valve.
16. Fuel-pump-rack actuator.
17. Air starting motor.
18. Counting switch.
19. Starting air valve.
20. Starting air pilot valve.
21. Pressure switch.
22. Water-temperature switch.
23. High-water-temperature switch.
24. Low-lube-oil-pressure switch.
25. High-bearing-temperature switches.

SCHEMATIC OF STATION and engine-control system. Engine does not have governor as such but uses a pneumatic speed transmitter sending air signal to speed controller which positions fuel racks. Fig. 1.

Here's how Great Lakes went about

Instrumenting an Unattended Diesel Station

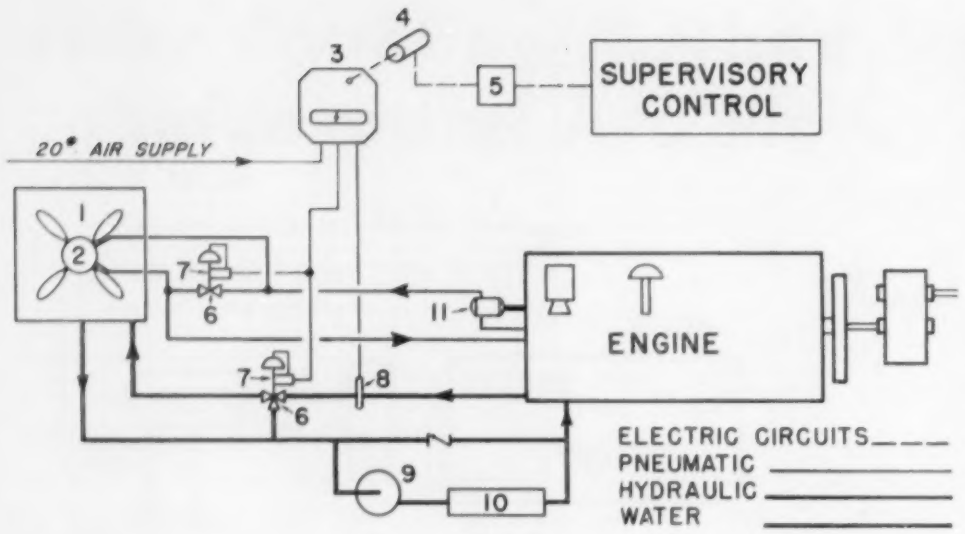
Designing an instrumentation system for an unattended diesel pump station is decidedly more complex than that for comparable electric stations. The design described here may be applicable to large multiunit stations—if not for unattended operation, at least for centralized local control, leading to more efficient operation.

by H. R. Hoyt
Great Lakes Pipe Line Co.

AN unattended diesel-powered pump station is somewhat of an oddity in pipelining. One big reason is that instrumentation is definitely more complicated than for electric stations. Great Lakes Pipe Line Co. has recently built a diesel station for unattended operation and this article will describe the control system developed for that station.

During the past half decade there has been a big upswing in the control instrument field. Feedback control has become a common phrase. The term "automation" has caught the fancy of laymen and has become a household word.

The pipeline industry is not lagging in this new trend. It has made use of automatic-control instruments for many years. Automatic pump stations were contemplated 20 years ago. Some experimental work was done along this line 10 or more years ago. The past 5 or 6 years has seen the development and construction of many fully



ENGINE COOLING SYSTEM uses double control system. One valve in water line to radiator has primary control. At higher heat loads control valve in hydraulic system acts to start and govern radiator fan. Fig. 2.

LEGEND

1. Radiator.
2. Hydraulic fan motor.
3. Temperature controller.
4. Gear-head motor.
5. Reversing switch.
6. Diaphragm-operated valves.
7. Valve positioners.
8. Temperature bulb
9. Auxiliary water pump.
10. Water heater.
11. Hydraulic pump

automatic, remote-controlled, electric-powered pump stations. Some have been completely unattended; others have operated with a single resident operator on call in case of trouble.

Some work has been done on automatic stations using diesel engines as prime movers. In general, the instrumentation required for successful control of a diesel-powered pump station is much more complex than that required for an equivalent electric station. For this reason, electric prime movers have been more popular to date for remote-control applications.

Unfortunately for pipeline engineers the majority of the manufacturers of control equipment have concentrated on controls for the process industries. In most cases the pipeline engineer has had to select from available controls those instruments most suitable for his need and modify them to fit the conditions at hand.

This article will describe in some detail the instrumentation developed for the control of an unattended diesel-powered station.

The station to be described was built by Great Lakes Pipe Line early this year. It is located near Topeka, Kans., on a 10-in. line which delivers products from El Dorado, Kans., into the company's main-line system at Kansas City.

The Topeka station is controlled from El Dorado. The supervisory equipment used is the all-relay type. Coded pulses transmit signals between the controlling and controlled stations. A specific code pattern is assigned to each function. Signals may start an action or indicate a condition (for instance, open a valve and indicate its position). This system works over a leased-wire circuit.

Station suction pressure, discharge pressure and engine r.p.m. are telemetered to the controlling station by equipment which operates on the timed-pulse principle.

General Station Layout

The pumping and control equipment is housed in a masonry building. Outside the building are the incoming and outgoing gates, scraper traps, hay-tank strainer, fuel-oil storage tank and recovery system.

The pumping unit consists of an engine, stepup gear, and four-stage centrifugal pump, all mounted on a structural-steel base. The engine is a 9 by 10½-in., six-cylinder, four-cycle supercharged diesel. It develops 800 hp. at 925 r.p.m. The pump is rated to deliver 1,340 g.p.m. against a head of 2,180 ft.

As installed, the pump end of the unit is separated from the engine and gear by a masonry firewall. A special seal is fitted around the high-speed shaft between the gear and pump. The building is divided into four rooms; engine room, pump room, control room, and storage room. The pump-room floor is 6 in. lower than the rest of the building floors as a safety precaution.

Reserve starting air . . . The control room contains the supervisory equipment, relay cabinets, a 48-volt d.c. power supply, and batteries. All control circuits and electrical devices operate on the battery supply to assure continuous operation in spite of possible a.c. power-line outages. Air bottles hold sufficient compressed air to operate all air controls about 2 hours after a power outage.

Engine-jacket water is cooled by means of an air-cooled radiator. The fan is driven at variable speeds by a hydraulic motor and a hydraulic pump direct, connected to the front end of the engine crank shaft. The radiator is mounted on the roof of the building.

An auxiliary water-circulating pump and electric heater make it possible to circulate and warm up the engine jacket water prior to starting the engine in cold weather.

Engine Controls

The engine control instruments are pneumatic, electric, and electromechanical in nature. The controls fall into three categories:

1. The devices which have to do with starting and stopping the engine and controlling engine speed.

2. The mechanisms which control the operating temperature of the engine.

3. Safety devices.

One of the devices in the first category is a pneumatic speed transmitter. This is a fly-ball mechanism driven by the engine. It delivers an air pressure proportional to the square of the speed of the engine. This signal is used to perform certain sequential functions dependent upon the speed of the engine and further to control speed when the engine is idling. A pressure gage with an appropriate scale also is fed by this signal and serves as a tachometer.

One of the most important instruments is the pneumatic-pressure controller which controls pump suction or discharge pressure by regulating engine speed. The output air signal of the controller positions the fuel-pump racks by means of a diaphragm motor attached to the rack control linkage. The

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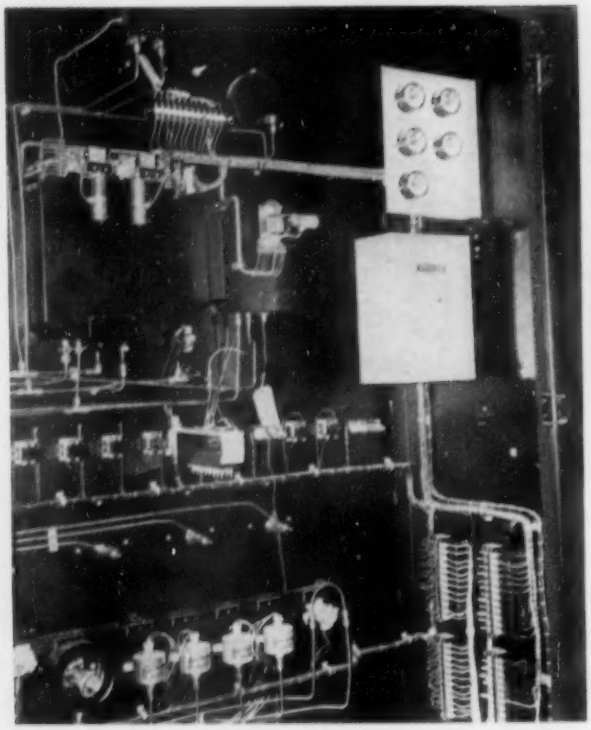
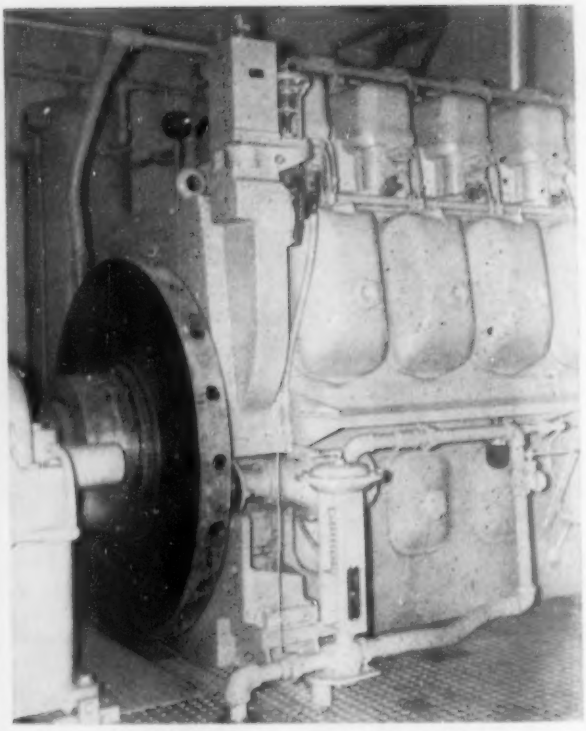


REAR OF ENGINE CONTROL BOARD. Gear motors for positioning set points can be seen on back of pneumatic controllers. Fig. 3.



SPEED TRANSMITTER AND ACTUATOR for fuel-pump rack are shown in upper center. The starting air valve is in lower center. Fig. 4.

engine does not have a governor as such.

The controller is a double-duty instrument with certain modifications. It has two pressure-measuring elements but only one nozzle and baffle assembly and one pneumatic-control unit. It has been modified in such a manner that either the suction pen or discharge pen can position the baffle through a special linkage. This makes for a more stable controller than the conventional instrument in which two control units are used and so arranged that either can override the other.

This unit has been further modified by the addition of two small gearhead motors which can position the suction and discharge set points by an electric signal.

Suction and discharge pressures are transmitted to the controller by air signals from two pneumatic-pressure transmitters located in the pump room. This eliminates all product gage lines from the engine and control rooms.

Operating Sequence

Fig. 1 is a greatly simplified schematic diagram of the station control system. The startup sequence is as follows: The start signal from El Dorado first causes the motor-operated incoming and outgoing gates to open. Closure of the upper limit switches on these gates actuates a small solenoid-operated pilot valve which operates the main starting air valve to crank the engine.

If the engine fails to start on the first bottle of air it is cranked again when the air pressure builds back up. The counting switch opens the starting circuit after five attempted starts and transmits a failed-to-start signal to the control station.

When the engine starts the speed transmitter immediately delivers an air pressure which rapidly increases as the engine speed increases. The output of this instrument is a 3-15-psi. signal. At 4 psi. a pressure switch opens the starting circuit cutting off the air to the cranking motor.

Engine idle controls . . . On startup it is, of course, desirable that the engine run at idle speed until it begins to warm up. It is impractical to use the pressure controller for idle-speed operation because there is no ready means of automatically selecting the proper set point under all conditions to give idle speed. The first attempt was to operate the engine on a fixed throttle during the warming-up period. This proved to be unsatisfactory.

The idle-speed controller shown in Fig. 1 works quite well. It consists of an instrument-type air regulator so modified that the regulator spring acts on the diaphragm through a lever system. The small diaphragm mounted to oppose the spring receives its air pressure from the speed transmitter driven by the engine. The output of the regulator goes to the engine fuel control. The result is that as the engine speeds up the transmitter air output increases but the idle-speed controller output decreases to slow the engine down. Thus the device becomes a governor. Tension on the spring adjusts the speed of the engine.

The output of the idle-speed controller and the output of the pressure controller both go to a selector relay. This relay passes the highest pressure signal on to the engine. At startup the output of the pressure controller is zero so the idle-speed controller controls the engine. When the engine is down the output of the idle-speed con-

THE AUTHOR

H. R. Hoyt is the chief mechanical engineer for Great Lakes Pipe Line Co. in Kansas City. He is a graduate of University of Kansas with a degree in mechanical engineering. Before joining Great Lakes he had various positions with Sinclair Refining Co. and Bell Telephone Co. He has been with Great Lakes for over 22 years and appointed to his present position in 1948.

troller is 12 psi., which puts the fuel-pump racks in the optimum position for starting.

This system gives excellent stability. Only one unit is controlling the engine at any given time. There is no cascade of controls, one resetting another.

The engine operates at idle speed until the jacket water reaches some preselected temperature. At this point, a temperature switch closes and starts the gear motor on the pressure controller; this, in turn, drives the discharge pressure set pointer up scale.

As this happens the output of the pressure controller exceeds that of the idle-speed controller and the engine slowly speeds up to the normal operating speed. Discharge pressure is limited at 1,000 psi. The suction pressure is normally held at 20 psi. or above. The suction set point on the controller can be raised or lowered by remote signal from El Dorado.

Shutdown Sequence

The station may be shut down in two ways. An emergency shutdown by one of the several safety devices on the engine or by a signal from the control station.

A solenoid actuated three-way valve in the air line to the fuel-pump rack control is deenergized (see Fig. 1). This dumps the air from the diaphragm operator producing a condition which shuts the engine down instantly. Other circuits are then energized causing the main station valves to close.

A normal shutdown requires about 15 minutes. The shutdown signal first starts the gearhead motor in the pneumatic pressure control and slowly lowers the discharge-pressure control point. This causes the engine to slowly decrease speed.

Simultaneously, the motor in the temperature controller lowers the temperature control point and starts cooling the engine down. When the engine reaches idle speed, as indicated by the signal from the speed transmitter, the three-way valve which causes the emergency shutdown is deenergized to shut the unit down. Circuits are then automatically restored to the proper condition for a startup.

Temperature Control Equipment

Fig. 2 shows schematically the engine cooling system. The water-circulating pump is an integral part of the engine. As previously mentioned, the radiator fan is driven by a hydraulic motor.

The temperature controller is a pneumatic instrument fitted with adjustable sensitivity and automatic reset. It has been modified by the addition of a small gearhead motor which can move the set point up and down scale.

There are two diaphragm-operated valves which serve to control water temperature. One is a conventional three-way valve which diverts more or less water through the radiator as required. The other valve serves to control the flow of oil to the fan motor. Both valves are fitted with positioners, set for split-range operation.

The single pneumatic instrument controls both valves. As the engine requires more cooling, the controller first shifts the three-way valve to shunt more water through the radiator. If, with 100 per cent of the water through the radiator, the engine requires more cooling, the diaphragm valve in the oil line is then positioned to send oil to the fan motor. The speed of the fan is controlled by this valve.

When the engine is shut down in the normal manner, the small gearhead motor on the temperature controller is used to gradually lower the control setting to cool the engine.

The auxiliary water heater and circulating pumps are used to warm the engine prior to starting in cold weather. This equipment can be turned on and off by a remote signal.

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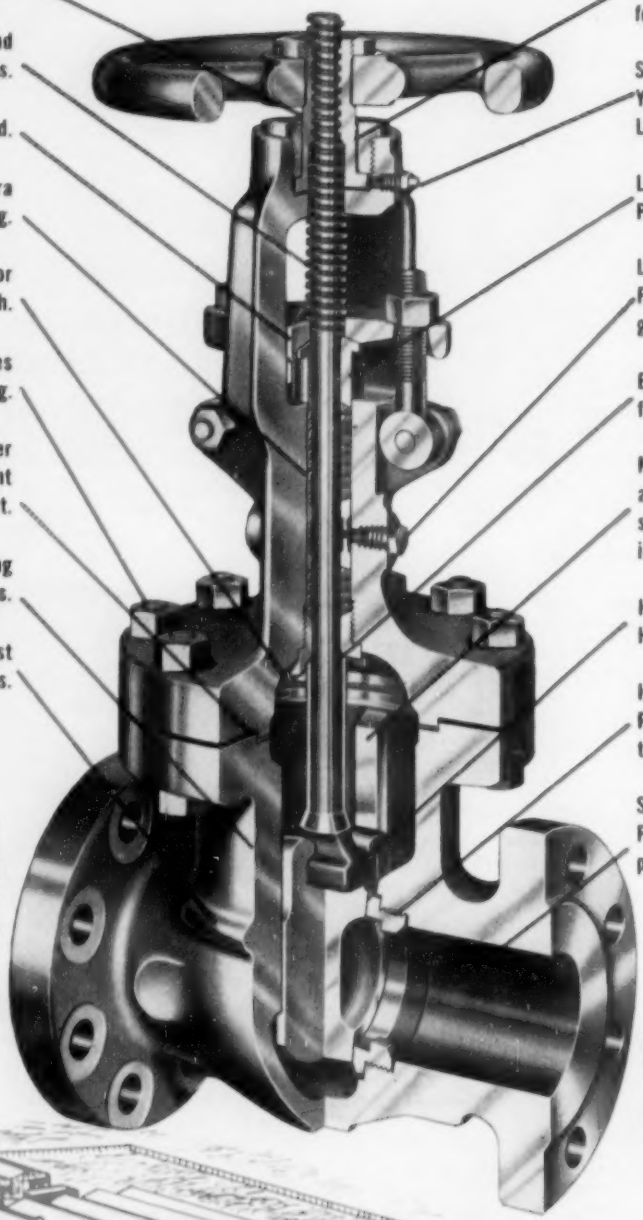

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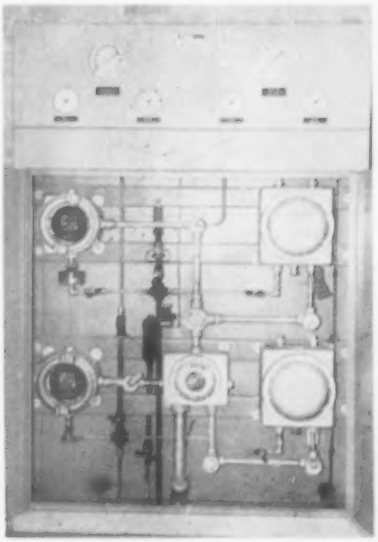
installed to protect the unit in the event of a malfunction.



TRANSMITTER CABINET for control system. Top section has pneumatic pressure transmitter. Below are the telemetering transmitters and pressure switches. Fig. 5.

Listed below are those conditions which cause the unit to shut down.

High jacket-water temperature
Low jacket-water level
Low lube-oil pressure
High gear-bearing temperatures
High pump-bearing temperatures
Low suction pressure
High discharge pressure
Engine overspeed
Low instrument air pressure
Pump seal leakage.

Other conditions which are indicated at the control station but which do not cause the unit to shut down are as follows:

High liquid level in station sump
High liquid level in fuel-oil day tank
Explosive atmosphere in pump room
Local electric-power outage
Unbalanced cylinder exhaust temperature.

Exhaust Temperature Monitor

A problem peculiar to diesel-engine operation is that of determining load balance between cylinders. This is normally done by comparing exhaust gas temperatures from each cylinder.

Equipment design specifically for this purpose which could indicate results over a supervisory system was not available. Combinations of available components such as scanning pyrometers, and telemetering equipment were extremely costly.

The system finally devised is simple and effective. The six exhaust-gas thermocouples which were standard equipment on the engine were used. They were connected in series with a meter-type relay inserted in the circuit between each pair of thermocouples. The thermocouples were connected alternately positive to positive and negative to negative. The result is that as long as all thermocouples are subjected to equal temperatures their outputs oppose and there is no current flow.

In the event of any cylinder running either high or low, the unbalance will actuate one of the relays and a signal is transmitted to the control station. The relays are adjustable and are set to actuate on a temperature spread of 50° F.

A multipoint selector switch can be manually thrown to connect the thermocouples to a conventional pyrometer for check purposes.

Operation

This station has seen limited operation due to late delivery of supervisory equipment. However, all local controls and instruments have functioned satisfactorily. When the supervisory installation is complete the station will be operated completely unattended. Inspection will be made at weekly or semimonthly intervals as experience dictates.

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• PIPELINEERING •

New Okan Line Employs New Concepts In Design, Operation

Designers of this products line were motivated by the desire to build as modern a pipeline system as possible. Result: a line completely electronically controlled, using equipment relatively new to the industry.

by E. A. Slade
Okan Pipeline Co.

ROUTE of Okan pipeline from natural-gasoline plants in Hugoton field to refinery center in Tulsa. Fig. 1.

THE design of Okan Pipeline Co.'s 340-mile, 6-in. products line allowed adapting of several new concepts and new types of equipment to pipelining. For example, it is believed Okan is the first pipeline system to be controlled entirely by electronics; control valves are powered electrically instead of by air or hydraulics; and wide use is made of a new type of flange joint—one using buna-N rubber O-ring gaskets.

Engineering Design

Due to the wide variation in plant production of natural-gas liquids, caused by seasonal gas requirements in areas served by the gas lines, several problems were encountered in the pipeline design. It is necessary that a balance be maintained among plant production, line capacity, working storage, and shipper and reports to the Interstate Commerce Commission.

Contractors were on the job in late April 1955; construction was completed to allow first movement of product by August 18, 1955. The eastern section of the line from Tulsa to Helena, Okla., was constructed by R. H. Fulton & Co., of Lubbock, Tex.; the remaining portion from Helena to Stano, Kans., was laid by Vaughn & Taylor Construction Co., of Odessa, Tex. Facilities at Liberal station and Tulsa terminal were built with contract labor under the direction of company personnel.

Okan Pipeline Only 2 Years Old

Okan Pipeline Co., a wholly owned subsidiary of Warren Petroleum Corp., was organized in November 1954. The key personnel have had considerable experience in the natural gasoline and pipeline industries. The company transports natural gasoline and L.P.G. from the Hugoton field area of southwestern Kansas to the Tulsa refining area. The route traversed is shown on the map, Fig. 1. The line gathers product from natural-gasoline-liquids-extraction plants operated on large natural-gas lines emanating from the Hugoton area. The line is a common car-

OVER-ALL VIEW of Okan's Liberal station shows pump units, manifold, control and office building. Fig. 2.

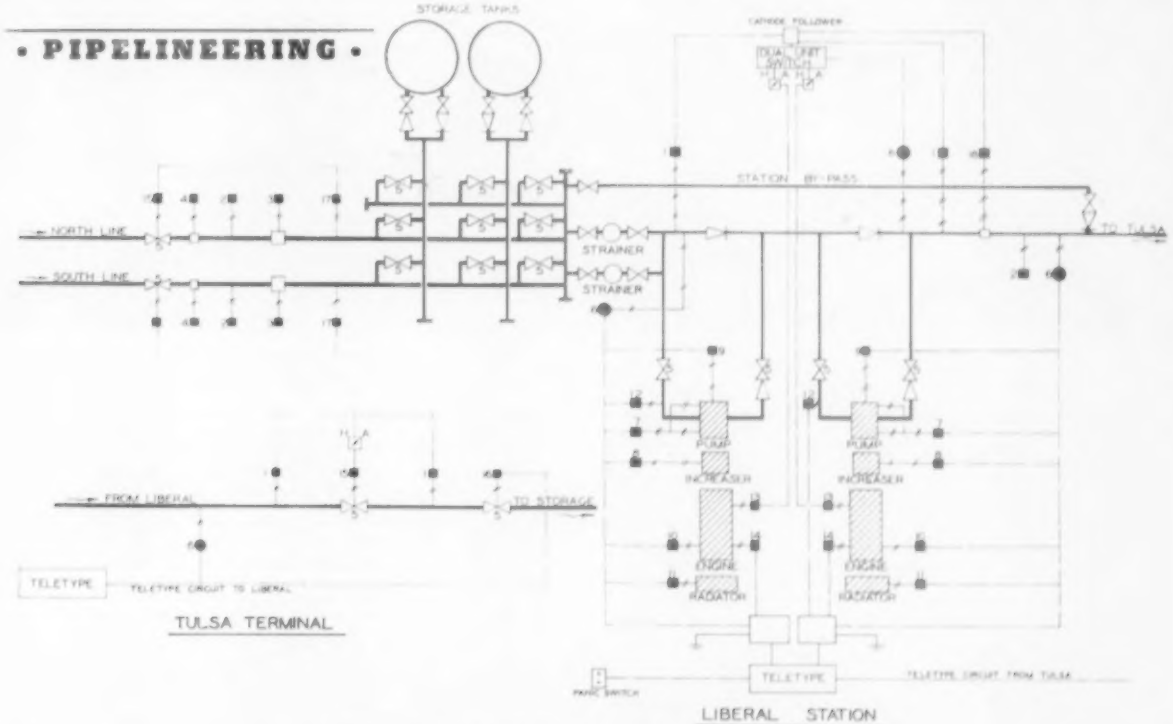
ENGINE-DRIVEN PUMPS operate through speed increasers. Electronics keep load balanced between engines when both are on line. Fig. 3.

per requirements. Each of the natural-gas-liquids-extraction plants has production storage and this tends to level out the volumes delivered to the pipeline. It is fortunate that the production of liquids at the plants is coincident with the seasonal requirements for natural gasoline used in blending at refineries and L.P.G. for domestic heating.

There is about 300 per cent variation in production between summer and winter. Lowest production is during the months of June, July, and August; peak production occurs during January and February. Peak production is 150 per cent of annual average and minimum production is 55 per cent annual average.

The line for the most part traverses an area inhabited only by jack rabbits as it crosses the dust bowl of western Oklahoma and the Cimarron River three times. This river is normally dry, but during construction about 3 years of rainfall occurred over a 5-day period; and as a consequence the river was nearly out of its banks when the crossings were constructed.

System hydraulics . . . There is an elevation difference of 2,050 ft. between Liberal station and the terminus of the line at Tulsa. This lends a considerable power assist in movement of product through the line. There was little available information in the literature concerning hydraulic friction factors to be used on natural gasolines and L.P.G. Hydraulics data for initial design of the system were determined by an evaluation of the available literature. A composite friction factor curve was made up from data using Fanning's equation, T. R. Aude formula, Williams and Hazen, and Moody's data. Actual operating data have proved the assumed average friction factor to be about 12.5 per cent high, resulting in



SCHEMATIC of control system for Liberal station. Fig. 4.

LEGEND

1. Pressure-recording controller.
2. Temperature recorder.
3. Specific-gravity recording-controller.
4. Flow recorder.
5. Motor-operated valve.
6. Mercoid pressure switch.
7. Seal failure.
8. Gear temperature.
9. Vibration detector.
10. Low lube oil.
11. Jacket-water temperature.
12. Low flow.
13. Engine governor.
14. Engine magneto.
15. Pressure-control valve.
16. Motor-valve controller.
17. Pressure controller.
18. Flow recording-controller.

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The new D7 was designed to work fast and efficiently in the rough going of the oil patches. For rig-moving, there's plenty of power in its new 128-HP engine – with up to 28,700-lb. drawbar pull.

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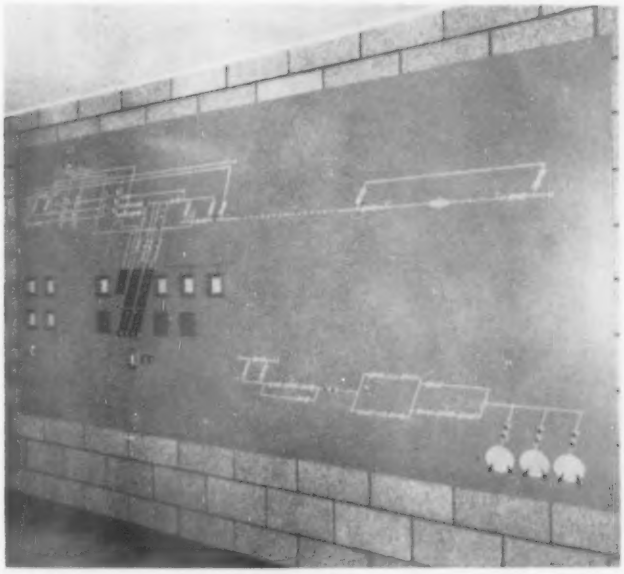
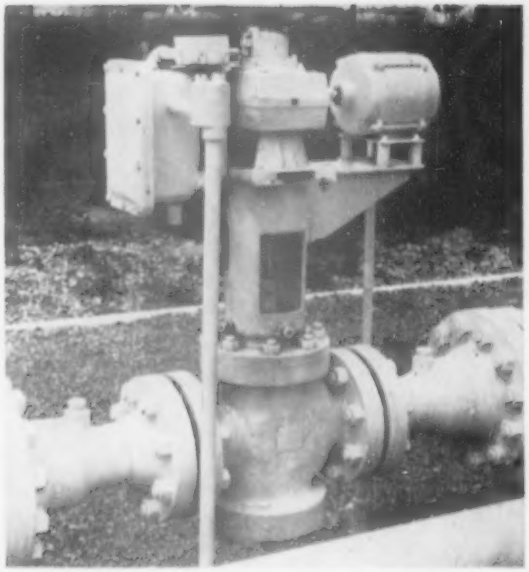


CONTROL PANEL located in Liberal station. Complete system and all controllable functions are shown here. Fig. 5.



ALL-ELECTRIC control valve located at Tulsa and used for holding back pressure on line. Motor moves double-ported valve from full open to close in few seconds. Fig. 6.

a greater capacity than originally anticipated.

Pipe used in the system is 6⅝-in.-o.d., 0.219-in.-wall-thickness, 14.97-lb. per ft. seamless pipe, A.P.I.-5L-X46 grade. X-ray inspections of welds was used to maintain quality control. All river, highway, and railroad crossings were X-rayed 100 per cent. A minute percentage of the welds examined was cut out, which attests to the improved quality of workmanship performed by pipeline welders. It is through the efforts of companies using rigid weld inspection and X-ray quality control that a pool of qualified welders is available to contractors for all pipeline construction projects.

O-ring flange gaskets . . . The line is coated with hard asphalt and 8-lb. transhield felt. Valves used on the trunk line are of the through-conduit, full-opening type, 600-lb. A.S.A. weld-end, with Teflon or synthetic-rubber seating surfaces. Insulating flanges with phenolic sleeves and gaskets provide cathodic-protection isolation. All other flange connections in the system use O-ring gaskets formed from a buna-N compound.

Main-line check valves are installed at approximately 30-mile intervals to prevent backflow of high-vapor-pressure product in the event of a leak or break upstream of the valve. A means for automatic closure of block valves is now being considered.

Station Design

Since the plants producing product for delivery into the pipeline had pumping equipment available that was suitable for deliveries into the pipeline, contracts were negotiated providing that plants deliver their production to meet a maximum of 500 psig. pipeline pressure.

Liberal station, shown in Figs. 2 and

THE AUTHOR

E. A. Slade, president of Okan Pipeline Co., has had a long and varied experience in the pipeline industry. He is a 1934 graduate of Colorado School of Mines with a B.S. in petroleum engineering. After graduation, he spent 7 years with various companies as a process and design engineer in gasoline plant work. During World War II he served in the Corps of Engineers, reaching the rank of major, and working principally on pipelines for the military. In 1945 he joined Stanolind Pipe Line Co. (now Service Pipe Line Co.) as a construction engineer. Later he was made superintendent of maintenance and construction and was responsible for all phases of that work for Service. In January 1955 he resigned from Service to accept the position of president of Okan Pipeline Co.

TYPICAL METERING INSTALLATION with temperature and pressure recorders, automatic rate-of-flow samplers, and meter prover. Fig. 7.

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3, is located about 12 miles northeast of Liberal, Kans. It is the only relay-batching station installed on the system at the present time. Due to the variable throughput volumes and high power rates in the area, gas engines with speed-increaser gears driving centrifugal pumps were selected as the most economical and flexible system. Two nine-stage, 4 by 6 by 9, Model DVMX, centrifugal pumps are installed. These are double-suction, opposed impellers, horizontally split case 2,000-psi. working-pressure pumps with balanced mechanical seals, having a delivery capacity of 580 g.p.m., 830 bbl. per hour at 2,700 ft. head or 800 psig. operating at an efficiency of 76 per cent.

The pump head-capacity curve at varying speed is such that it very nearly matches the pipeline loss curve, and allows operation at near maximum efficiency over wide variations in flow rates. This economical type of operation is possible only by use of a variable-speed drive.

The engines driving these pumps are 12-cylinder, 5,788-cu.-in. displacement with maximum b.m.e.p. of 70 psig., spark-ignited gas engines having a manufacturer's rating of 850 hp., derated to 510 hp. A 3.94:1 ratio speed increaser drives the pump at 3,540 r.p.m. with the engine operating at 900 r.p.m. The engine can operate satisfactorily under load between 500 and 1,100 r.p.m., giving a wide range of pump capacity.

The station manifold at Liberal is designed for the segregation of three or more different products from three incoming lines. All incoming lines are equipped with scraper traps and pressure regulators to maintain back pressure and prevent intermixing of product during batching operations. Manifold and tank lines are constructed of 10-in. pipe to provide a minimum of 11 ft. n.p.s.h. on the main-line pump suction. Liberal station is a batching point and by proper use of plant storage, batch scheduling, and station working storage a minimum amount of high-pressure working storage is required.

Automatic Sequence Starting and Control System

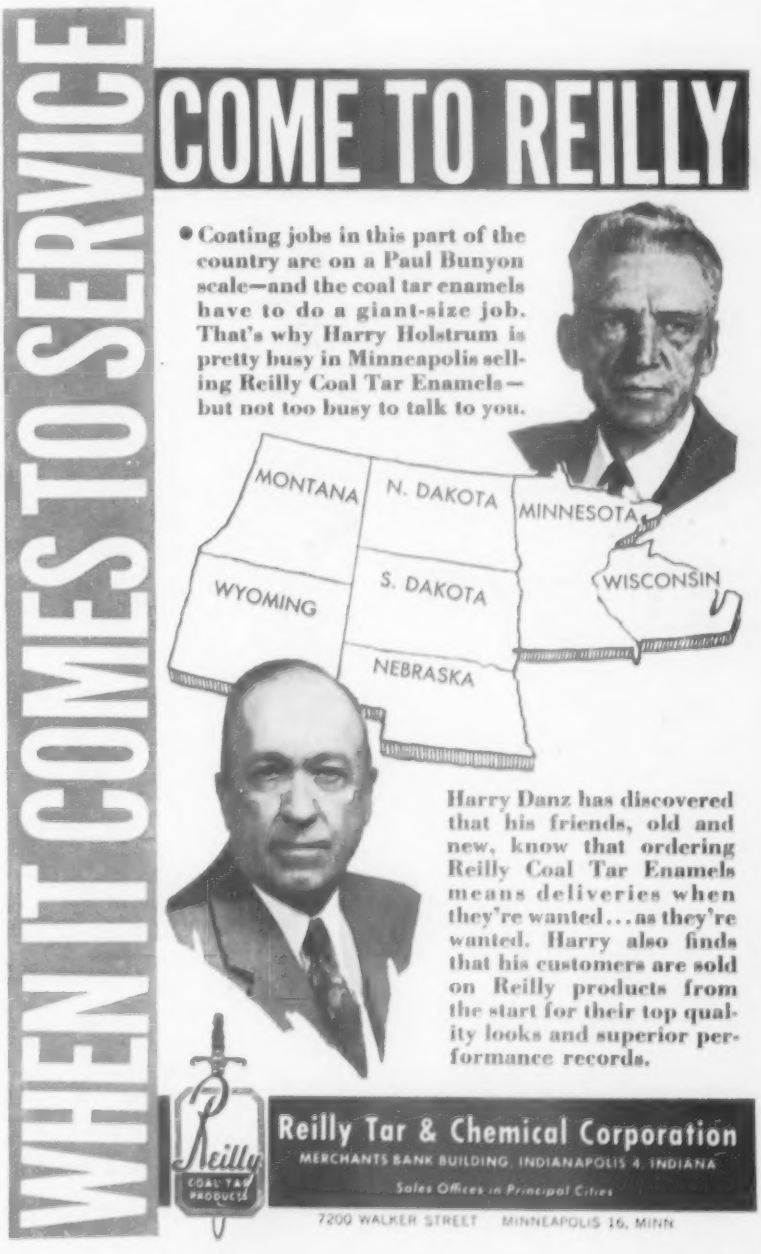
The controls used at Liberal station are all electronic and this installation is believed to be the first pipeline station in the industry to be so controlled. Basic control of the main-line units is obtained from a rate-of-flow controller on the station discharge. The flow-control instrument is set for the desired rate and by controller output through a cathode follower to an electronic servo, the speed of the engine is controlled through a hydraulic governor.

Suction and discharge pressure-controller outputs are fed into the cathode followers with the output of the flow controller. The controller with highest input takes over control of the engine through its electrohydraulic servo governor.

In the event the suction pressure goes below a minimum fixed limit or the discharge pressure exceeds a maximum fixed limit, the control circuit stops the unit or units. The station pumping equipment consisting of two identical units is remotely controlled from the station building and may be started and operated manually or automatically by remote sequence control. A schematic diagram of the control system is shown in Fig. 4.

A graphic control panel, Fig. 5, located in the control room displays the physical layout of the station and pipeline system and provides the operator with a convenient method for remotely controlling and monitoring the entire system operation.

System divides load automatically . . . When the operator presses the start button for one of the pumping units, he starts a sequence of automatic functions that puts the unit into operation. Suction and discharge valves open, electric starting motors crank the engine, and the engine is held at idle speed by the hydraulic governor. After the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engine has warmed up, the governor control is taken over and the speed of the engine is regulated according to the position of the flow controller index and the engine speeds up to meet set rate.

If the operator sets the index for a flow rate in excess of the capacity of one unit, the second unit will come on the line automatically regardless of which unit is operating. With two-unit operation the control system divides the load equally between the two. A drop in flow requirements within the capacity of one unit will cause a unit to drop off the line automatically and put the entire load on the remaining unit. When a unit stops operating, the suction and discharge valves return to the closed position automatically.

Under the sequence starting system, open position limit switches on the suction and discharge valves energize solenoid-operated chokes and at the same time energize the electric starter motors on the engine. The cranking cycle is limited by a time delay relay to 15 seconds' cranking time. If the starting motors do not successfully start the engine in 15 seconds, everything returns to its normal position and the operator is alerted by a sequence failure indication. He must then reinitiate the starting sequence.

On an engine start the electric starter is deenergized by an engine manifold vacuum switch and the choke solenoids are deenergized by a pressure switch in the engine lube-oil system. Speed controls on the engine are preset so the engine will run at idling speed until the electrohydraulic governor controller loop takes over. Control of the engine is passed to the governor by a temperature switch in the cooling-water system. Indicating lights tell the operator when the engine is under governor control.

The governor is in turn regulated by an electronic flow-rate controller through an electric servo motor. The operator sets the controller to the desired flow rate and the servo system drives the governor to reposition the engine throttle valve to obtain the required power output. Safe operating limits are maintained by station suction and discharge pressure controller. If the flow controller attempts to exceed set limits, the pressure controllers override the flow controller and hold the flow within these safe limits.

Shutdown features . . . Indicating lights on the graphic panel show the position of the suction and discharge valves. Red lights show closed valves, green lights show open valves, and flashing red or green lights show the valve is traveling to a closed or open position. Strip-chart recorders mounted in the panel indicate the temperature and flow in all incoming and outgoing lines. Panel-mounted suction and discharge pressure recorder-controllers control the pumping units as described above.

Protective features include: (1) Low lube-oil pressure, (2) high jacket-water temperature, (3) high gear-box temperature, (4) vibrating detectors, (5) seal failure, (6) low flow, (7) high discharge pressure, and (8) low suction pressure.

Any fault condition that will actuate one of the above protective features will ground the engine magnetos and alert the operator. Indicating lights on the graphic panel show the operator which condition caused the shutdown. The pumping units may be operated manually without sacrificing any of the above protection.

All critical valves in the station manifold are equipped with explosionproof electric operators with remote push buttons and indicating lights located on the graphic panel. Local push-button stations are also located in the manifold area. All valve starter and switch gear are located in the control building.

A teletype circuit between the station and the terminal is used for the dual purpose of telemetering and teletypewriting. The Liberal operator has control of the circuit and may gage tanks

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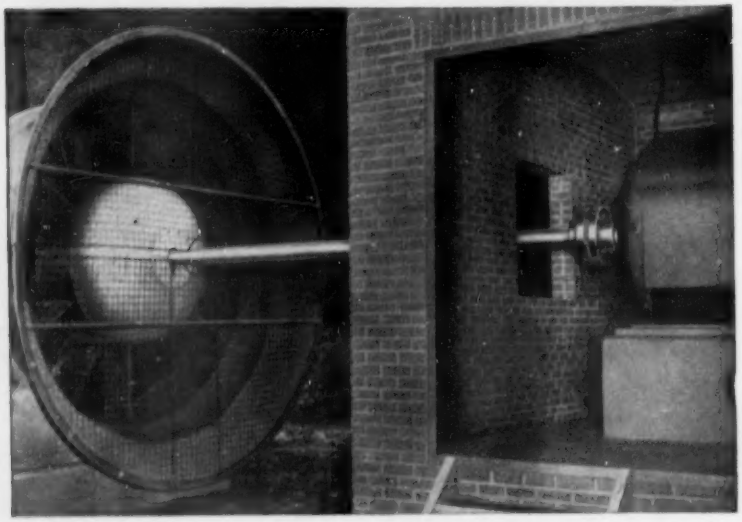

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and operate valves located at the Tulsa terminal.

Electric control valve . . . Due to the 560-psig. static head at Tulsa terminal, it was necessary to provide safety equipment to prevent damage to low-pressure facilities within the refinery limits. Under normal operations, a back pressure of 90 to 100 psig. is maintained so that the line will be completely filled over terrain control points. Control is effected by means of two electronic pressure controllers controlling an electrically operated double port parabolic plug control valve. The back pressure control described above causes the valve to open as flow increases and the set point on the controller is exceeded. The electric operated control valve is shown in Fig. 6.

Connected into and operating the same control valve through a cathode follower unit is a controller set to limit downstream pressure on the control valve to 150 psig. This controller drives the control valve toward a closed position when pressure exceeds 125 psig. and the valve is completely closed at 150 psig. These limits can be changed up to 300 psig. of downstream control pressure when handling 225-lb. R.v.p. product.

In addition to the electronic controllers, a pressure switch upstream of all valves at the terminal is set to open at 300 psig. The opening of this switch causes an electrically operated 600-lb. A.S.A. gate valve to close and this valve cannot be opened until the pressure switch is manually reset. The opening of the pressure switch also breaks a normally closed telemetering circuit. Any open condition on the teletype circuit, whether due to an overpressure or communications failure between the Tulsa terminal and Liberal station, will after 30 seconds time delay shut down the pumping units at Liberal station.

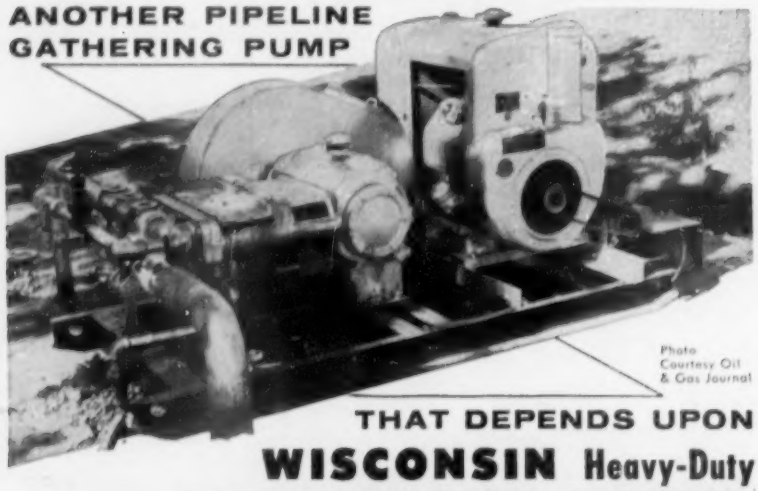
If shutdown occurs due to overpressure, the teletype circuit is automatically restored to operation after a 60-second delay to allow communication. The units cannot be restarted, however, until the overpressure switch at Tulsa is closed manually. This control is provided to prevent extremely high pressures being exerted on the pipe at the Tulsa end of the system. Provision is made for automatic starting of a standby power unit and an automatic transfer switch to supply power to essential control, lighting and communication facilities.

Gaging and metering . . . Pulse-code electronic tank gages are provided on Liberal working storage and Tulsa receiving tanks, allowing remote gaging of terminal tanks from the Tulsa terminal building and all tanks from Liberal station over telemetering circuit.

Provisions have been made for the installation of interface or specific-gravity detectors for automatic switching of products in the proper working tanks. Under normal operations when batching high-vapor-pressure product, the station acts as a relay on the incoming stream and additional product can be taken from working storage to meet trunk-line rate.

The working storage at Liberal station is suitable for the storage of 26-lb. R.v.p. product. A gas blanket of natural gas is maintained in the tanks to prevent evaporation loss of product. A 4-in. water line open-ended on the top of the tank provides a means of flooding the outside surfaces of the tanks with water during extremely hot weather or in the event of a fire nearby. The use of a water flood will help prevent rupture of the tank in the event popoff valves fail to function or do not have sufficient capacity. An internal spider apparatus is installed in each tank to allow the blending of various vapor pressure products in working storage to meet shippers' requirements.

ANOTHER PIPELINE GATHERING PUMP



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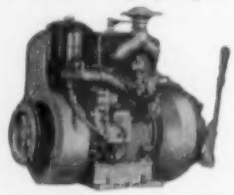

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At each of the plants delivering into the line a positive-displacement type of metering station was constructed in accordance with A.P.I.-A.S.M.E. code for positive-displacement meters using gas displacement of prover tanks. A representative installation is shown in Fig. 7.

Operations and Maintenance

During initial filling of the line, air was purged from the line by use of natural gas at 350 psig. Gas was vented from the line at each of the valve locations through the side-tap plugs. This venting procedure removed all of the air and using practices common in the natural-gas industry of pressuring and venting and repressuring sections, a large amount of loose mill scale and sand was removed. The purging and cleaning of the line with natural gas required about 10 days.

During the initial fill of the line with product a batching type of scraper was inserted into the line ahead of the product. The scraper was well greased with plug-valve lubricant to minimize wear on the scraper rubbers. During the line-fill operation, some wear did occur on the rubbers and approximately 300 bbl. of product bypassed the scrapers.

Injection points for corrosion inhibitor are installed at each of the plants where product is received and at Liberal station. Inhibitor is injected to maintain a concentration of approximately 30 p.p.m. This concentration will be reduced when the line is completely inhibited. A cathodic-protection system, using rectifiers and carbon anode ground beds has been installed to give complete external corrosion protection to the pipeline system. A decal in four colors was designed to fit the plate at the top of the milepost markers.

Early leaks . . . Aerial patrol of the system is carried out once each week and to date the patrol pilot has a .666 batting average on discovery of leaks. Three leaks have occurred on the system since it was put into operation. The first one was discovered when the line was filled and was due to puncture of the pipe by the contractor during cleanup operations. The other two leaks were due to laminations in the pipe; one lamination occurring 5 ft. from the end of the joint and the other 15 ft. from the end of the joint.

The last leak was very erratic in nature in that the loss through the leak varied from 0 to 60 bbl. per day. For 3 months during the winter it was known that a sizable leak existed. After a long search it was finally discovered in the top of a sand dune, where there was no visible evidence or odor.

Pressuring of the line between valve sections and excavation of the pipe at 2)-ft. intervals over an 8½-mile distance finally located the leak. A gas detector was used in the bottom of each test excavation and no indication on the instrument was obtained until a point within 50 ft. of the leak was reached.

Radioactive stream switcher . . . Gaging and testing of product are performed by gagers having long experience in the natural-gasoline industry, who are familiar with natural-gasoline plant practices and policies. Product is measured in accordance with A.P.I.-A.S.M.E. positive-displacement-meter code and is tested in accordance with N.G.A.A. specifications. Provision has been made at batching, terminal, and receiving points for automatic batch indication by the use of radioactive cells, showing 0.001 specific-gravity change.

An automatic batching control system is now being installed on a line recently constructed between Snyder and Big Spring, Tex. The radioactive type cells actuate electric motor-driven valves to switch the product into the proper receiving tanks. Two feeder lines each handling two different products deliver into the same tankage.

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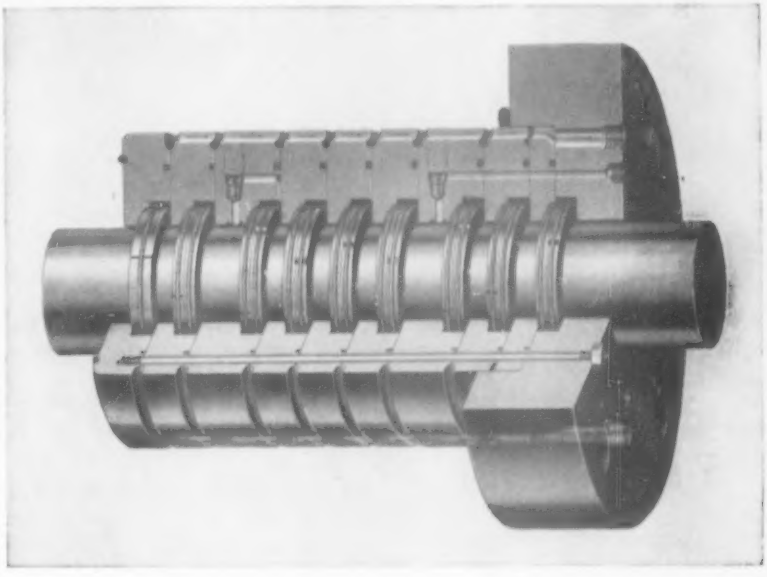

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(Laminated Bakelite: Standard Hi-Temp and Graphitized)
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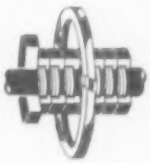

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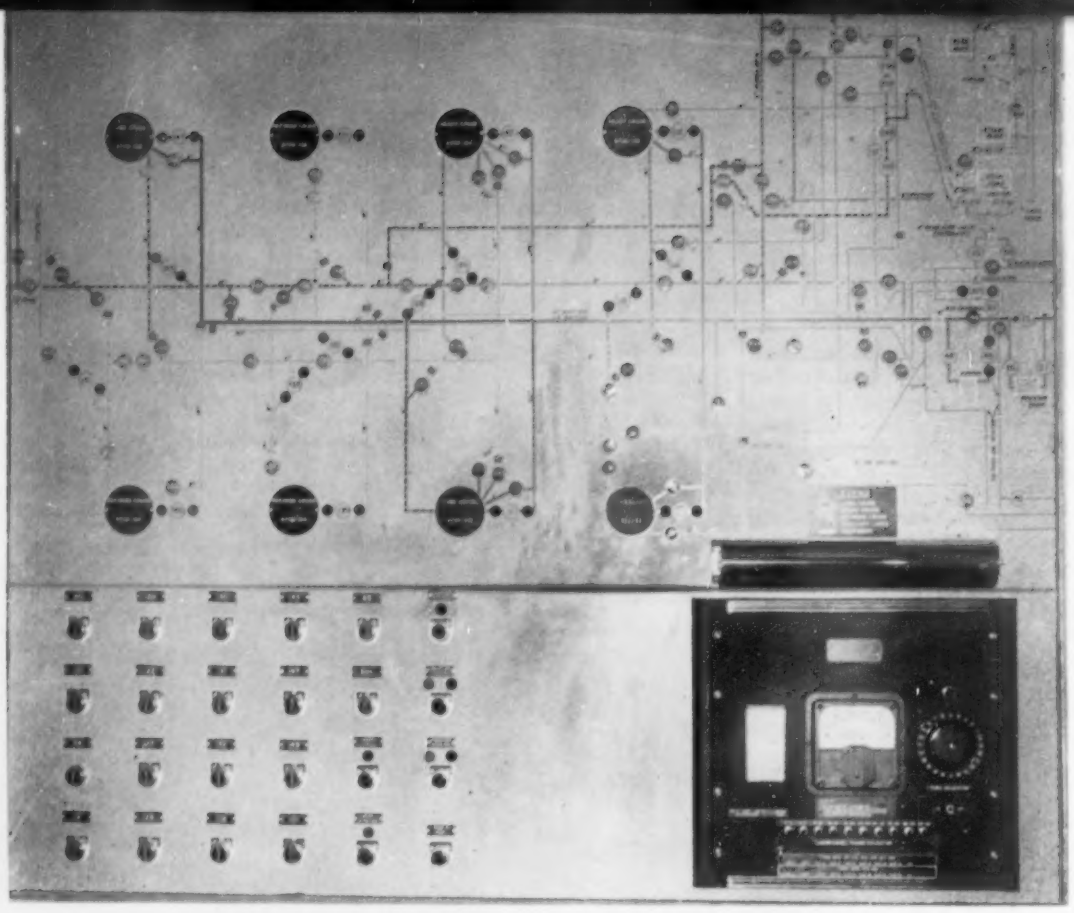


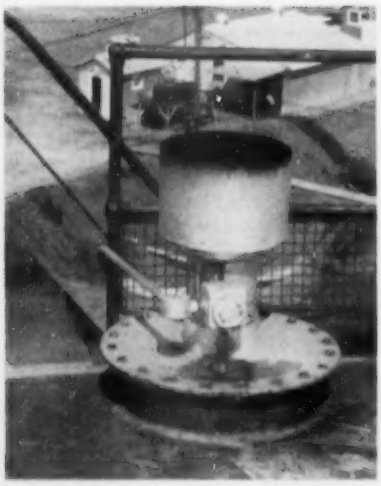
GRAPHIC CONTROL PANEL at Shell's Bakersfield, Calif., pump station.

Semiautomatic Operations

at a crude-oil tank farm and pumping station

by T. F. Phillians

Shell Oil Co.



BULB-ASSEMBLY UNIT, used through manhole cover.

ELECTRONIC tank-gaging equipment, with the remote-reading instrument located in the pump-station office, has been used successfully for the past few years at Shell Oil Co.'s Bakersfield, Calif., pump station.

Operations have been improved and made more efficient by the addition of remote-controlled motorized valve operators, remote-reading average-tank-temperature measuring equipment, and crude-oil continuous line-sampling equipment.

The Bakersfield pump station, with its attendant tank-farm facilities, is the initial station on the Bakersfield-to-Coalinga pipeline system. The pump station and tank farm are spread over a 40-acre site. Crude oil from the southern part of the San Joaquin Valley is accumulated at the tank farm and then shipped on at a 45,000-bbl. per day rate to the Coalinga tank farm.

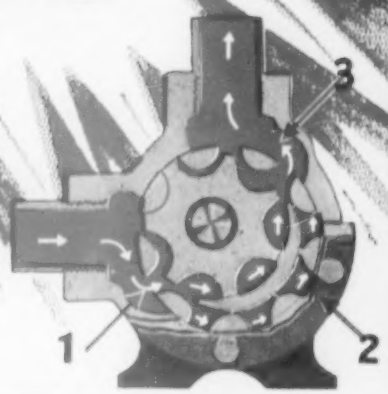
Crude-oil storage at the tank farm consists of eight 68,000-bbl. tanks having an aggregate capacity of 544,000 bbl. Main-line pumping units consist of three steam-turbine-driven centrifugal pumps with exhaust-steam heat exchangers, used for heating the heavy viscous crude oils before shipping.

Over-All Control System

Only valves that are frequently operated, such as the filling and suction valves of the eight storage tanks and two other valves required for the switching of main suction lines, are motorized. The control of the motor operators is carried out at a graphic control panel, located in the pump station office.

PUMP NEWS!

Five New and Improved Series of Wayne ROTARY PUMPS



Quiet, long-life, high-efficiency rotary pumps for every industrial application . . . all thoroughly pretested for handling alcohol, asphalt, brines, caustics, chemicals, dyes, fruit juices, gasoline, greases, lacquer, oils, starch, sulphuric acid and other products of varying weights and viscosities. These five pumps will efficiently handle all:

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SERIES C—Rugged Duty Packed—for medium or high viscosities at operating pressures up to 200 psi.

SERIES D—Rugged Duty Sealed—for liquefied gases and other fluids of very light viscosity.

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These new Wayne Pumps give positive action and higher volumetric efficiency. Have only two moving parts—the driver rotor precisely balanced in the casing, and the idler—with Wayne's exclusive rolling gear circular tooth design. With a Wayne you can pump the same GPM with smaller, lighter-weight unit.

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Wayne POSITIVE DISPLACEMENT DESIGN

1. **Liquid is drawn into pump by suction created when pumping elements are disengaged.**
2. **Crescent acts as valve, preventing backflow.**
3. **Fluid is forced out discharge port as pumping elements re-engage.**

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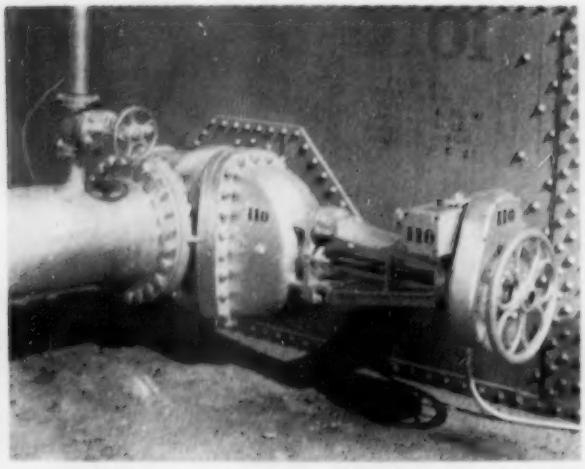
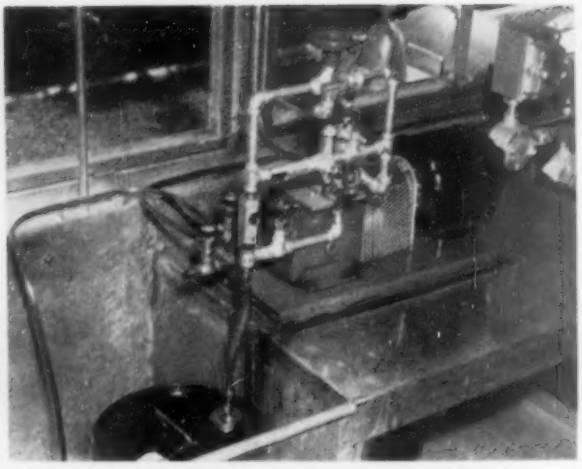


TYPICAL MOTOR-OPERATED VALVE installation on tank suction line.



COMPOSITE SAMPLING UNIT for crude oil.

Average-tank-temperature equipment was installed on each of the eight storage tanks. The remote-reading instrument was installed on the graphic control panel in the pump-station office.

Automatic equipment was installed at two separate locations for taking continuous crude-oil line samples to determine A.P.I. gravity and b.s. and w. content. One sampling unit was located within the pump room where its operation could be easily controlled by the station engineer. The other sampling unit was located at the far end of the tank farm on an incoming filling line, with its motor control on the graphic control panel in the pump station office.

Remotely operated valves . . . Eighteen valves, which vary in size from 6 to 18 in., are equipped with motor operators. Separate push-button controls for each motor operator were installed on the graphic control panel located in the pump-station office. These valves are the most frequently operated in making tank switches from individual storage tanks into the main-line pumping-unit suction lines.

All motor operators are field-mounted on the existing valves. This required the removal of the valve yokes to a nonhazardous area for welding the mounting plates to the yokes.

Power-supply circuits for the motor operators are 440-volt, 3-phase, 60-cycle using No. 14 TW color-coded wire and the control circuits are operated at 110 volts single phase 60 cycle using No. 16 TW color-coded wire. The reversing starters are housed in a separate control center located outside and adjacent to the pump-station building.

All conduit was installed aboveground on channel-iron bents except in the pump-station area where it was placed underground after the application of a protective enamel coating.

Tank-temperature equipment . . . This equipment provides a means whereby the average temperature of the crude oil stored in any one of the eight 68,000-bbl. tanks can be read on the remote indicator and selector instrument located on the graphic control panel in the pump-station office.

The installation consists of the nine-resistance-element bulb assembly enclosed within a flexible metal tube, which is suspended in each of the storage tanks with entrance through a top manhole cover plate; the stepping-switch units, which are mounted on a support near the outside base of each tank; and the remote average-temperature indicator and selector instrument, which is located on the graphic control panel in the pump-station office.

Each bulb assembly has nine resistance elements, which are of varying length. Each element extends down to within 6 in. of the tank bottom. The elements are electrically connected to the contacts of the stepping switch, which is wired to the average-temperature indicator and selector instrument. This consists of an indicating instrument, calibrated in degrees Fahrenheit, and two selector units, the tank selector, and the liquid-level selector for each tank.

The tank-selector unit is a dial switch that completes the circuits between the selected tank and the other receiver components. The liquid-level selector unit is a series of nine toggle switches, which cover a range of liquid level in the preselected tank.

Connecting wiring for this installation using No. 16 TW color-coded wire within steel conduits was accomplished with maximum economy because of the efficient switching design and tank grouping arrangement. Conduit for this installation traversed the same route used for the motorized valve power and control conduits.

Continuous sampling . . . The installation of this equipment permitted continuous samples of crude oil to be taken at two separate locations, which were required for semiautomatic operation of the pump station. One of the units was installed on the suction side of the main-line pumps of the pump station and the other unit was installed on a 6-in. filling line to tanks in which purchased crude oil was stored. The A.P.I. gravity and b.s. and w. content of the crude oil are determined from these samples.

The units are identical and consist of a small chemical feeder pump driven by a ¼-hp. Class I, Group D electric motor. This operates on 110-volt single-phase 60-cycle a.c. current. Feeder and pump are mounted on a common steel base. A minimum amount of small piping was required

THE AUTHOR

T. F. Phillians is a mechanical engineer in the transportation and supplies department, Pipe Lines - Pacific Coast, of Shell Oil Co. After attending Miami University, he entered the service of the company in 1927 in the survey and drafting department. In 1943 he transferred to the pipeline department and has since been engaged in design and construction of pipelines, pump stations, and special control instrumentation. He is a registered professional engineer in California.

for making connections. The samples are collected in a 5-gal. can, which is vented to the atmosphere. Maximum capacity of the small pump is 2½ pt. per hour.

The small single-plunger pump is located on the outside of the steel case which contains the oil-immersed driving parts for the pump. Power is supplied to the vertical pump plunger through a plate connection from the top of the vertical driving rod. This is connected to the electric motor through a reduction gear and cam assembly. The quantity of the sample obtained is regulated by simply moving the regulating nut up or down on the pump plunger to lengthen or shorten the stroke.

Graphic control panel . . . This graphic control panel is located in the pump-station office. The motorized valve-control buttons are conveniently located in the lower left-hand corner of the panel. The green and red minalites (motorized - valve - position - indicating lights, green for open, red for closed) are located on each side of the motorized valve. This appears in its proper position in the flow diagram occupying the upper two-thirds portion of the control panel.

The flow diagram shows the piping arrangement used for the control of various types of crude-oil movement through the tank farm and pump station. Various colored lines are used to indicate the route of certain types of crude. All unmotorized valves and blind plate flanges appearing on the flow diagram have their operating position identified by red and green interchangeable plastic magnetic indicators. (Red indicates a closed valve and blind plate; green an open valve and orifice plate).

"Yes sir, Son, you're following the footsteps of a mighty big man on this job."

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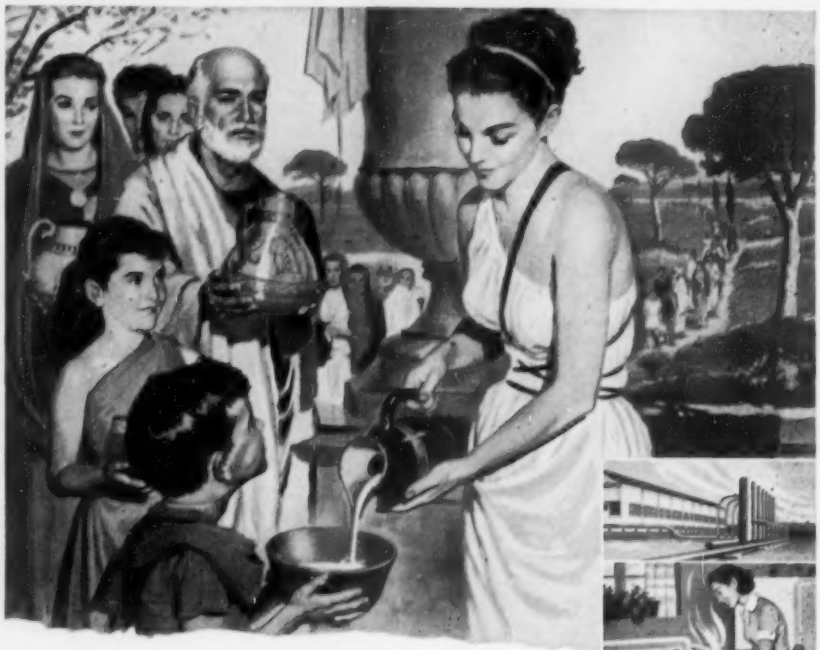

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DELIBERATE "BURN THROUGH" of pipe wall is made by all welders in training program. This photo was made at the exact instant of complete penetration.

SIMULATION of main-line repair job with gas in line. Note fire at top of pipe where welder is working.

This Program Results in Better Welders

Here are details of a welder training program which simulates actual field conditions—even to a "burn through" of a line under pressure. It's a way to get better maintenance welding.

by David C. Palm
Natural Gas Pipeline Co. of America

WELDERS play an important part in the organization which operates and maintains the pipelines for Natural Gas Pipeline Co. of America and its affiliated companies.*

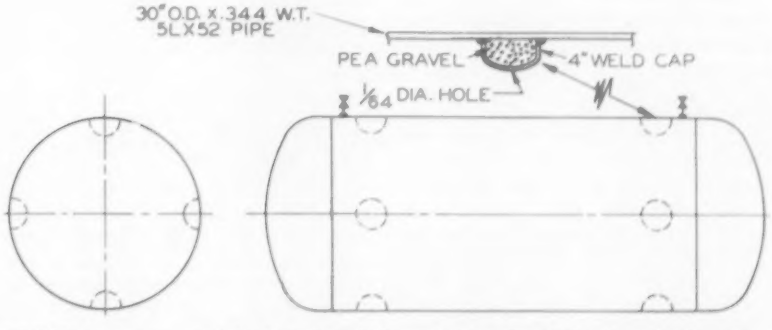
These men must necessarily be skilled in fitting and welding piping and related materials. But beyond the routine assignments there are occasions when welders must turn out a proficient job under adverse conditions. At times it is difficult to prepare and fit the members to be welded. Sometimes surges of gas and attendant fire at the point of the work add to the adverse factors.

Logically, a welder who has had experience in these situations will be able to do a more competent job under the same set of circumstances at a later date.

So, in order to further the competence of these key men, our companies devised a series of welder-proficiency meetings which incorporated controlled conditions simulating an adverse welding assignment. Other general welding information was also part of the program.

These are, to our knowledge, the first of their kind in the natural-gas-transmission industry.

*Texas Illinois Natural Gas Pipeline Co. and Natural Gas Storage Co. of Illinois.



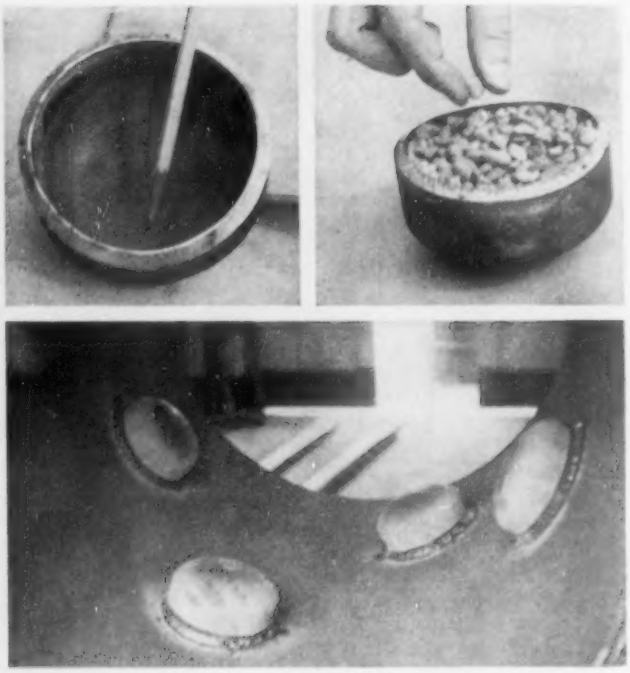
DESIGN of pressure vessel for burn-through demonstration. Penetration is made at pressures up to 600 psi. of natural gas.

Organization of Program

Six separate groups each met for 2 days, testing their skills and studying newer phases and techniques of welding as it applies to their specialized fields. As a preliminary step, each welder prior to the meeting made a typical weld, under typical conditions which was thoroughly analyzed. The result of the meetings was a certification of proficiency for all welders; a source of satisfaction to the men and an assurance to the company.

Much of the material for the programs came from the welders and from engineers and superintendents in the field maintenance and and operating organization. The round-table discussion method, led by supervising personnel, permitted a free exchange of ideas and emphasis on the companies' standards and specifications. The latter are based on the A.P.I. Standard 1104 which establishes certain requirements for field welding of pipelines. However, many modifications are required to fit the situations peculiar to pipeline-maintenance work. Slides and other visual aids were used to supple-

X-RAYS WERE TAKEN of each welder's work and the welder given a chance to inspect the pictures for defects in the weld.



HERE'S HOW PIPE CAPS were placed inside pressure vessel. Pea gravel inside cap minimizes volume of gas to escape after burn through.

ment discussions. Shop demonstrations to emphasize many important points added to the interest.

In any group of men such as a welding component of a pipeline organization, there are men with an abundance of experience and outstanding special skills. Such men were selected to give the discussion or demonstration on their specialty. The informal type of program and the opportunity of the younger men to question their more experienced fellow craftsmen were highlights of the meetings.

X-rays check test welds . . . Recognizing that basically the work of a welder is cutting, fitting, and welding piping and pipe fittings, a part of the program was devoted to this routine phase of welding and how to secure the highest quality of work. Discussions and demonstrations in minimizing arc burns and eliminating under-bead cracking, gas pockets, slag inclusions, and other defects were of wide interest.

The use of X-rays for the checking of welds, while relatively new, is now an accepted tool of the welding industry. Therefore, the company was interested in familiarizing its welders with this development as a step in keeping them posted on new techniques pertaining to welding. Being familiar with the operations of the X-ray equipment and an ability to interpret X-ray films, broadened their range of welding knowledge.

A portable X-ray machine and a skilled X-ray technician checked each welder's work and gave the welder an opportunity to observe any defects in it. The intent of the X-ray work and all other phases of the program was constructive and meant to help the welder increase his proficiency. Also, it indirectly demonstrated the degree of his skill.

"Hot" welds at high pressure . . . The gas-transmission industry has a long and successful experience record on welding by the electric-arc method on pipelines under conditions of normal operating pressures—the so-called "hot welding" technique.

Such a procedure is necessary for side tap connections and for certain maintenance work. Top pressures under which welding is considered to be safe is a subject that has not been definitely established and certainly it is a field where judgment and experience must play an important part. Welding has been performed on a pipeline operating at a pressure approaching 72 per cent of the yield point of the pipe steel. This is the operating pressure permitted under the A.S.A. B31.1, American Standard Code for Pressure Piping. Pipeline operators do recognize that pipe-wall thickness, rod size, and welding heat influence the safety factor. Much test work has no doubt been engaged in by various companies or groups in the industry on the safety factors and quality of welding under various operating pressure conditions. But the published material on the subject has been very meager and has left questions unanswered.

Pipe thickness tests before welding . . . The Audigage thickness tester, used in industry for determination of laminations in plate and for checking internal corrosion of closed vessels, is standard equipment of our companies in connection with welding on pressurized pipes. This instrument was explained and demonstrated at the meetings, so that company welders would have a general understanding of how it functions and know its capabilities.

The instrument measures metal characteristics when one side is accessible. It operates on the principle of ultrasonic resonance, that is, acoustic energy of a certain wave length which is transmitted into the material. A reflected wave length is in phase with the transmitted wave at certain frequencies. This enables the technician to determine the thickness of material and locate inclusions or separations within the mass of the material.

In considering welding on any pipeline under pressure, it is of utmost importance that there is sound metal under the welding arc. Internal corrosion or other metal deficiencies would decrease the safety factor for pressure welding.

Various pipe samples with internal

defects were used in the demonstrations without the technician's knowledge of where the defects lay. The detection of them by the Audigage was conclusive evidence to our welders that any defects in pipe in the lines where welding under pressure was contemplated would be definitely established.

"Burn-Through" Under Pressure

On of the most dramatic and certainly one of the most interesting activities at the meetings was the "burn-through" demonstration in which all welders had an opportunity to participate. This brought out very favorable comments from the welders. It gives a more definite answer than has been available to them on the subject of welding and penetrating the pipe wall with an electric arc when the line is under operating stresses.

To make such a procedure absolutely safe and permit the welder to actually burn through the pipe wall under operating pressure conditions, we used a method of minimizing the amount of gas under the arc without reducing the stresses in the pipe wall which are caused by internal pressure.

Design of burn-through vessel . . . The apparatus for this demonstration is a short section of pipe similar to that used in the pipeline system. We use a 24-in. o.d. and a 30-in. o.d. by 0.344 wall pipe with welding heads on the ends and the necessary connections for pressuring and purging. However, before the welding heads were attached, a series of 4-in.-diameter welding caps filled with pea-sized gravel were welded to the internal circumference of the pipe. And before they were welded, a 1/64-in.-diameter hole was drilled in the center of the cap. The location of each cap on the inside of the cylinder was marked on the outside pipe circumference so that there was no question of its location after the vessel was sealed. The purpose of the gravel was to occupy space so as to limit the volume as much as possible.

The purpose of the 1/64-in.-diameter hole was to permit the pressure in the vessel to also equalize inside of each cap. The entire assembly was thoroughly purged with gas by numerous slow pressurizing and venting cycles.

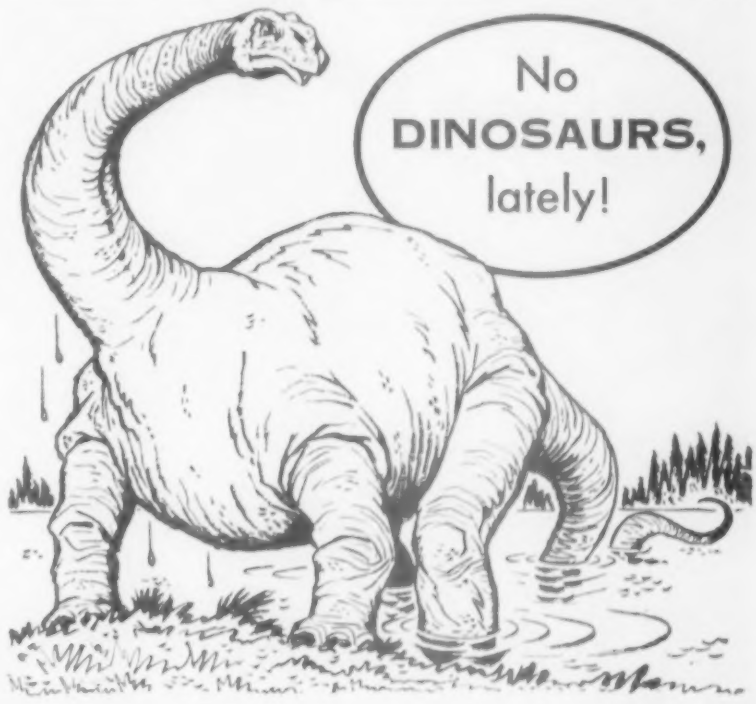
"In considering welding on any pipeline under pressure, it is of utmost importance that there be sound metal under the welding arc. Deficiencies would decrease the safety factor."

Though the device limits the amount of gas in the area occupied by each of the caps, it does not limit the gas pressure nor the stress in the pipe wall at these points.

A test pressure was placed on the vessel of 1.10 times the pressure at which welding was to take place. The

THE AUTHOR

David C. Palm, general superintendent of pipelines for Natural Gas Pipeline Co. of America and Texas Illinois Natural Gas Pipeline Co., has spent his entire engineering career in the petroleum industry. A graduate of Stanford University, he began work with the Cities Service organization in engineering and supervisory capacities. His experience background includes a wide range of construction of oil and gas refining, processing, transmission and measurement facilities. He has been with Natural Gas Pipeline Co. in various capacities since the company was organized. He was advanced to his present position in 1952.



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(A) The majority of incoming liquid and solid particles are directed down into reservoir. 1

(B) Lighter solid particles carried by gas stream are separated on surfaces of contactor which are kept wet and clean by revolving from liquid reservoir. 2

(C) Contactor is revolved by explosion-proof gear motor.

(D) Mist Extractor removes any remaining liquid particles from gas stream prior to outlet. 3

- The **dust removal ability** of the SCRUBOSPHERE **is superior** because it utilizes wetted surfaces for dust collection which are much more closely spaced than in conventional equipment.
- **Oil loss is minimized** because the oil used to wet the dust collecting surface is lifted mechanically instead of bubbling gas through the oil which results in foaming and loss due to creation of hard-to-separate fine particles.
- **Maximum performance and low cost** — The spherical design means high capacity and performance because it provides maximum dimensions for the contactor and mist extractor which normally are limiting factors in scrubber designs. The vessel cost is reduced because required vessel thickness is only one half that required for cylindrical vessel of same diameter.
- **Versatility** — separates solid and liquid particles with equal efficiency.
- **Low pressure drop** — ½ to ¾ psi at rated capacity depending on nozzle size.

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Write for test data showing dust removal and oil loss of Peerless Scrubosphere as against conventional dust scrubber.

first experimental welding on the vessel at the locations above the pipe caps as indicated by the markings on the vessel was at a pressure of 100 psig. Then in successive steps the pressure was raised to 300 and 600 psig.

All get chance to burn one . . . Each welder was permitted to experiment with various rod sizes and various welding heats, and finally, to actually burn through the pipe wall.

When the arc completely penetrated the pipe wall the puncture in the bottom of the crater was very small, usually less than the size of the lead in a pencil. The first observation upon penetration was a spray of minute molten-metal particles which were blown out of the crater accompanied by a whistling of the escaping gas. This lasted for only an instant, however, due to the limited volume. But, at the instant of penetration, the gas pressure at the point of penetration was the full pressure of the simulated pipeline.

One of the interesting points brought out by the demonstration was the difficulty of penetrating the pipe wall with the arc using a 5/32-in. rod size. Some of the newer welders had some difficulty in burning through. With effort, skilled welders penetrated the pipe but not in the course of depositing metal in connection with normal welding.

It was not the purpose of these demonstrations to minimize the need for caution in welding on pressured pipe. Rather it was intended to assure quality welds on "hot" work by giving the welder confidence in being able to secure normal penetration of the pipe with safety.

Safety Practices Stressed

This discussion of the meetings has dealt primarily with quality of welding under the diverse conditions encountered in pipeline maintenance. Safety to personnel was given equal emphasis, however.

Perhaps foremost in a discussion of safe practices to be followed by welders engaged in pipeline maintenance is the inviolate rule of checking for a gas-air mixture before lighting a torch or striking an arc if there is a possibility of the presence of gas. All crews in our organization are equipped with a combustible gas detector.

A complete review was given of the safety precautions accompanying the use of gas-flame cutting equipment. This covered proper storage of gas cylinders, the importance of keeping oil away from oxygen equipment and the importance of keeping hoses and equipment in good repair.

A topic related to cutting and welding operative gas lines is the subject of purging. Complete air exclusion prior to welding so as to eliminate combustion inside of pipes or vessels is common practice. This requires purging at atmospheric pressures and maintenance of a supply of purge gas in the line at the site of welding without building up the pressure. Two-way radio contacts with personnel at valves and vent connections facilitates close control of this operation.

Prevention and first aid for eye injuries from arc flashes belonged properly in a prominent place on the program.

Fire-fighting equipment of the dry-chemical type handled by experienced personnel, is another must in welding around gas in our companies. If, inadvertently, an excessive gas fire should result, the chemical is released immediately to snuff out the flames.

In addition to the attendance of the field supervisory personnel at the meetings, a representative of the operating division of the home office, Chicago, was present at every session. This interest and the enthusiastic endorsement of the program by the companies' management was one of the contributing factors to its success.

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EL PASO STATION where Southern Pacific's eastern pipeline starts. Products are pumped through 426 miles of 8-in. to Phoenix.

Veteran railroad goes into pipeline business

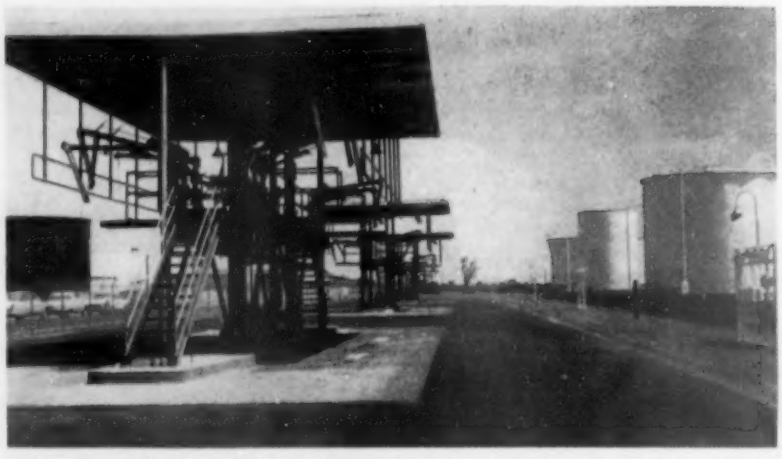
S.P. Line Transports 30 Products

. . . Here's a cross-section view of its operations

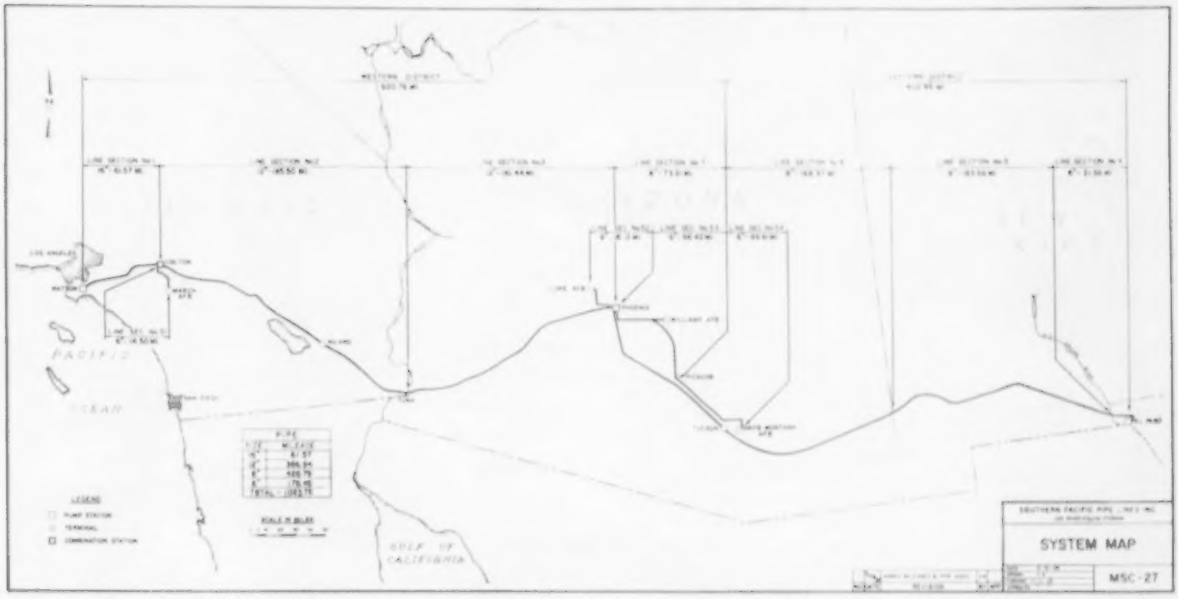
by M. A. Levy
Southern Pacific Pipe Lines, Inc.

OPERATION of the new products system of Southern Pacific Pipe Lines, Inc., presents a complicated problem of serving 100 different shippers and the U. S. Air Force. Thirty different products go through the line, all requiring tight quality control, close dispatching, and accurate interface cutting.

Supply areas for the system are centered 800 miles apart in Los Angeles and El Paso. The main terminal and end point for most shipments is near the midpoint between these supply areas. Thus, Southern Pacific's pipeline system consists of two separate lines, one from each of the supply areas, plus short lines to serve air bases. Over



PHOENIX TERMINAL which is served by lines from both El Paso and Los Angeles. Quality-control tanks used in handling military products are at right.



ROUTE MAP of Southern Pacific Pipe Lines, Inc. Line is looped between Phoenix and Tucson since all military products come from Los Angeles.

177 miles of spur line have been laid for exclusive use of the military.

General System Description

The idea of constructing a products pipeline to supply California and Arizona markets was conceived in the fall of 1954. A feasibility report was completed in January 1955, and late in February 1955 the project was approved. From the beginning Engineering Management, Inc., was in charge of all design and construction, and in record time the project was completed. On January 3, 1956, product began to move from El Paso toward Phoenix.

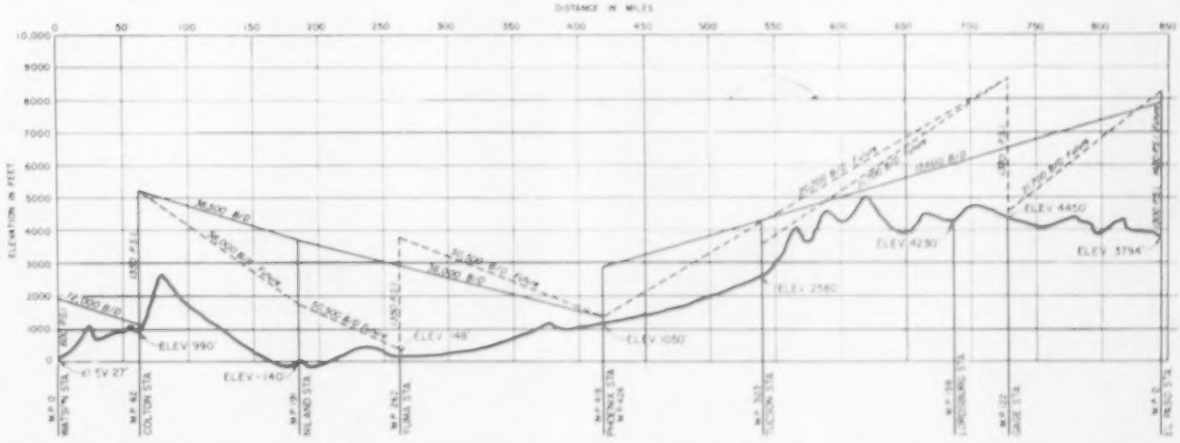
Southern Pacific Pipe Lines is presently operating about 844 miles of pipeline from Watson, Calif., near Los Angeles, to Phoenix, Ariz., and from El Paso to Phoenix. Lines are used jointly by military and commercial shippers. Additional 6-in. pipelines have been built for military use between Colton, Calif., and March Air Force Base (14.4 miles); between Phoenix and Luke Air Force Base (18.1 miles); between Phoenix and Williams Air Force Base (40 miles); and between Phoenix and Davis-Monthan Air Force Base (approximately 140 miles).

Phoenix is the terminal point for both pipelines; pumpings cannot be made from Watson to El Paso or vice versa. However, in case of a national emergency the pipeline could be quickly modified so that product could move

THE AUTHOR

Murray A. Levy is superintendent of the products movement department for Southern Pacific Pipe Lines, Inc., with headquarters in the Pacific Electric Building in downtown Los Angeles. He came to the new company in that capacity in August 1955, and organized this department while the pipeline system was still under construction.

He joined Southern Pacific Pipe Lines after having been with Plantation Pipe Line Co. since 1942, with time out for World War II service as a first lieutenant in the United States Air Force. He is a graduate of Louisiana State University with a B.S. degree in petroleum engineering.



PROFILE OF LINE showing extreme differences in elevation on both main lines. Phoenix has to hold a back pressure of about 600 psi. when El Paso is on stream with two units.

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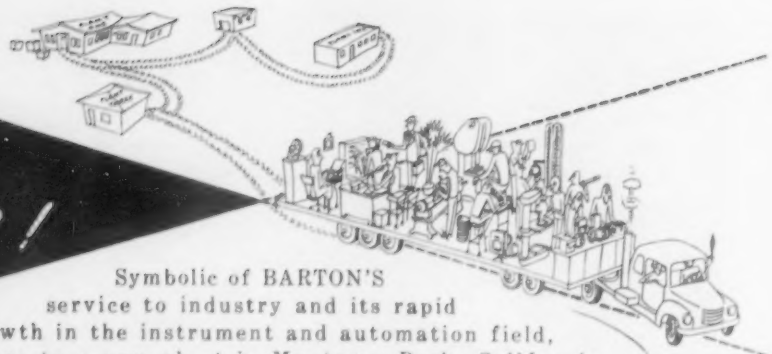

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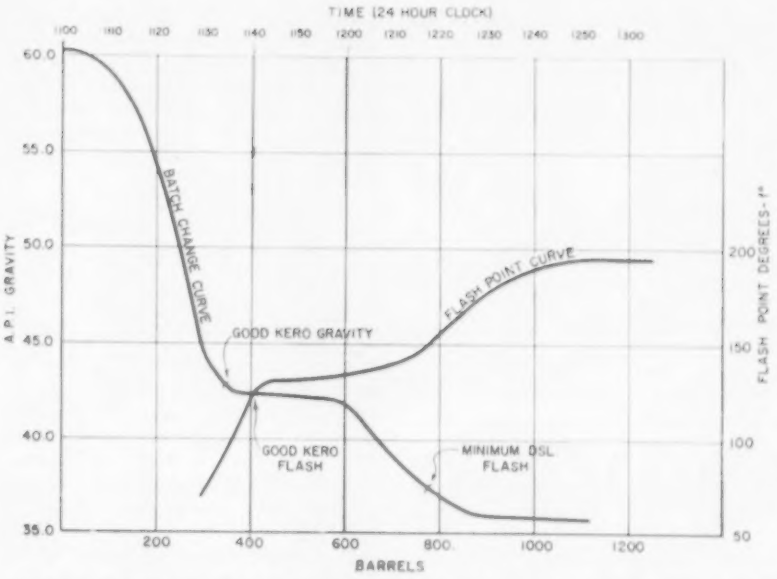

TYPICAL BATCH CHANGE at Phoenix after 426 miles of travel from El Paso. Cut is made slightly below the good kerosine gravity point.

from the El Paso area to the West Coast or from the West Coast into El Paso.

Four stations on line . . . The western segment of the line is made up of about 62 miles of 16-in. pipe between Watson and Colton and 356 miles of 12-in. pipe between Colton and Phoenix. The eastern segment of the pipeline is composed of 426 miles of 8-in. pipe. Because of extreme elevation differences on both segments of the pipeline, high discharge pressures must be used to maintain the design throughput requirements.

Four main-line pumping stations are located along the system at Watson; Norwalk and Colton, and at El Paso. Terminal facilities are located at Colton, Niland, Phoenix, and Tucson.

The Watson station acts as a receiving point for all commercial products that enter the system from the refineries located in the Los Angeles area. About 12 miles downstream from Watson is the Norwalk station from which all military products originate.

When Watson is operating, Norwalk station must be shut down and bypassed. Conversely, Watson is shut down during pumpings from Norwalk.

Because of the close proximity of these two stations, the same operating personnel is utilized to maintain and operate both stations. To offset pressure restrictions in the highly industrialized and residential section between Watson and Colton, and to afford the greatest amount of flexibility in pumping rates, main-line units are connected in parallel. Two four-state centrifugal pumps coupled to 300-hp. electric motors form the motivating power for normal operations while the third unit is used as a standby equipment.

The suction manifold at Watson is connected to pumping equipment owned by the refineries.

Suction-line system . . . Since Southern Pacific Pipe Lines is dependent upon the refinery to supply suction, a great deal of coordination is required between refinery personnel and personnel at Watson station to allow switching from one refinery to the other without a shutdown of the pipeline. Because some refineries are located as far as 10 miles from Watson, it was necessary to install pressure control valves at the incoming manifold to prevent over pressuring the suction manifold.

In cases where refinery rates are less than pipeline rates, three tanks with booster pumps are provided to allow receipts into tankage before the batch is scheduled to go to the pipeline. All receipts into the system and deliveries from the system are measured by positive displacement meters.

Colton station is a combination booster station and delivery terminal equipped with three five-stage centrifugal pumps connected in series to 900-hp. electric motors. As in the case of Watson, the third unit is used for standby service. Metering facilities are comprised of two positive displacement meters, either of which is capable of taking full-line stream flow. In addition to being a combination main-line station, Colton is also equipped with one 300-hp. unit used for the pumping of military products to March Air Force Base.

At Niland delivery facilities are provided. Two positive displacement meters, either capable of taking the full stream, are installed at this terminal.

Phoenix, hub of system . . . In addition to serving as a terminal point for both lines, Phoenix is equipped with five positive displacement meters and four 200-hp. pumping units which are used for the pumping of military products to Luke, Williams, and Davis-Monthan Air Force bases.

Like Niland, Tucson is strictly a delivery terminal and is equipped with two positive displacement meters. Personnel assigned to Tucson is also utilized in operating the delivery facilities at Davis-Monthan Air Force Base.

The El Paso station, which operates in much the same manner as Watson in the Los Angeles area, serves as a receiving point for all product pumped into the 8-in. line. Here again the utmost coordination between the personnel of the refineries and of the pipeline must be maintained to avoid any shutdown of pipeline facilities.

Operation

Ten commercial shippers and the United States Air Force move 30 different products through the pipeline. Complete segregation is maintained on each product. Quality control practices are severely observed in this section of the country. This requires operations and switches at source points, as well as at terminal points, to be extremely precise inasmuch as diesel, commercial gasoline, aviation gasoline, and jet fuels are pumped through the system.

The scarcity of buffer material on both ends of the line has magnified the problem, as shippers do not have tankage at terminal points to accommodate such movements. This means that the buffer batches on the 8-in. line and on the 16-in. and 12-in. system must be sized so that the kerosine-gasoline mixture or the stove-oil-gasoline mixture can be blended into a gasoline, and the kerosine-diesel or stove-oil diesel cut directly into the diesel without affecting a change in specification.

Just enough good stove oil or kerosine must remain in the center of the contaminated slug to serve as a good switching point. Since the flash always lags good gravity, we have found it wise to wait until 1° to 1½° below good gravity is obtained before switching into diesel storage. When small batches of diesel follow the contamination slug, an on-stream flash is run before switching to diesel tankage.

The importance of quality control

in the handling of military products cannot be too greatly emphasized. A special booklet covering military operating procedures has been issued to the Air Force quality control office and to the field personnel of Southern Pacific Pipe Lines for guidance in handling Air Force products.

Jet fuel and aviation gasoline must pass very rigid tests and, therefore, must be handled with special care. On Air Force product there can be no compromise — all Air Force product must be cut clean. Pumpings cannot be made from tankage to military laterals while receipts into the same tanks are in progress. After each tank is filled with the required product, the tank is sealed, gaged, and sampled.

The seal remains on the tank until approximately 2 hours before feed to one of the military lines provided all required laboratory tests have been passed. To meet the quality control requirements, two 55,000 and one 30,000-bbl. floating-roof tanks have been installed at Colton, and three 67,000 and two 30,000-bbl. floating-roof tanks have been located at Phoenix.

Complete lab facilities . . . Laboratory facilities have been established at Phoenix where tests are made according to Federal Tests Standard No. 791 which deals with lubricants, liquid fuels, and related products. Such tests as gravity, appearance, color, distillation, Reid vapor pressure, freezing point, existent gum, potential gum, precipitant corrosion, water reaction, and analine gravity product are accomplished on jet fuel.

Additional tests such as TEL content, knock rating (lean mixture and rich mixture) are made on 115-145 aviation gasoline. Distillation, gravity, color, and flash tests are performed on commercial products.

No percentage deduction . . . All accounting for products consigned to the Air Force is based upon 100 per cent delivery. This means that upon receipt of a batch of product into the system, Southern Pacific Pipe Lines issues a metered ticket to the Air Force covering the entire batch. The Air Force in turn issues bills of lading assigning the proper distribution to each Air Force base, the total of which makes up the quantity shown on the metered ticket.

Upon receipt of the quantity of product shown on the face of the bill of lading into Air Force tankage, the local base transportation office must execute the completion of the bill of lading before Southern Pacific Pipe Lines can bill the Air Force for transportation charges.

At the close of each monthly period the products accounting section issues a summary of inventory in gallons. This shows the beginning inventory, receipts into the system during the month, deliveries to the Air Force bases, the closing system inventory, and the shortage resulting from handling and cutting product clean at intermediate storage.

Settlement for this shortage is made on a monthly basis, and after settlement has been made for the shortage, the amount of the shortage in barrels is applied against the current bill of lading for product being delivered at one of the Air Force bases.

Other Terminal Facilities

Southern Pacific Pipe Lines operations are not solely confined to transporting product through the pipeline but reach out to extend to its shippers plans for complete terminal operation. The company has constructed for its shippers about 600,000 bbl. of tankage complete with individual truck-loading facilities. Such tankage and loading facilities are operated by pipeline personnel on a tank rental and service-charge basis. Other shippers along the system have elected to construct their own terminal facilities, and these provide an additional 750,000 bbl. of storage.

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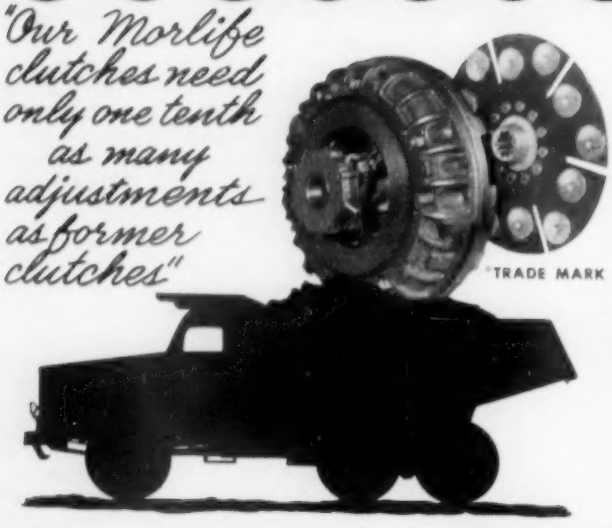

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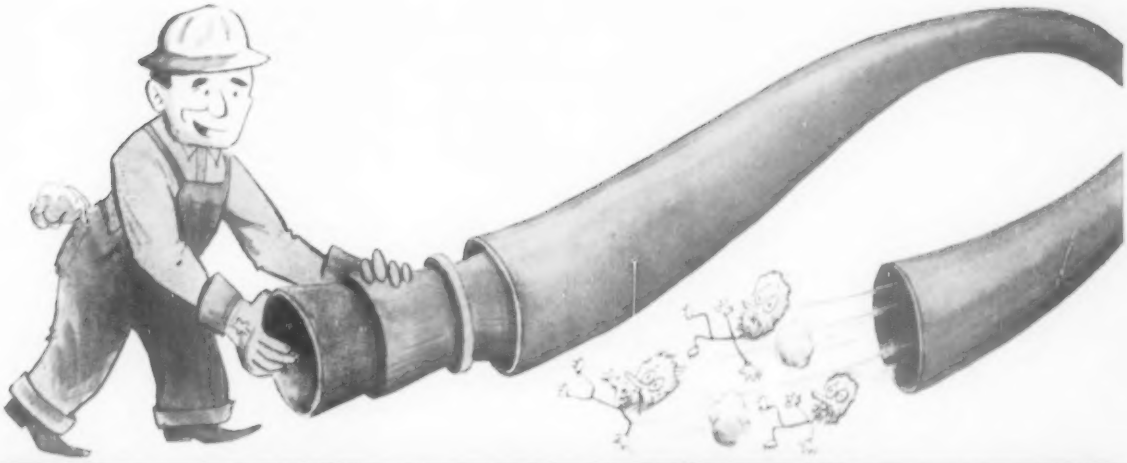

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A. C. Curtis, inventor of Pipelife Process and president of Pipecote Service Corporation.

R. H. Durst, Project Engineer, International Minerals & Chemical Corporation, Chicago.

Tom B. Cotten, General Superintendent, Pipecote Service Corporation.

A Stopple station where three hot-taps were made in the main line, diverting the flow of water into two parallel bypass lines.

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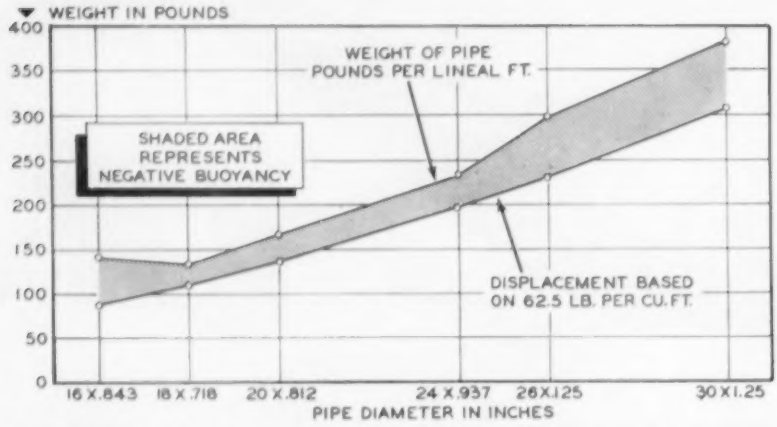
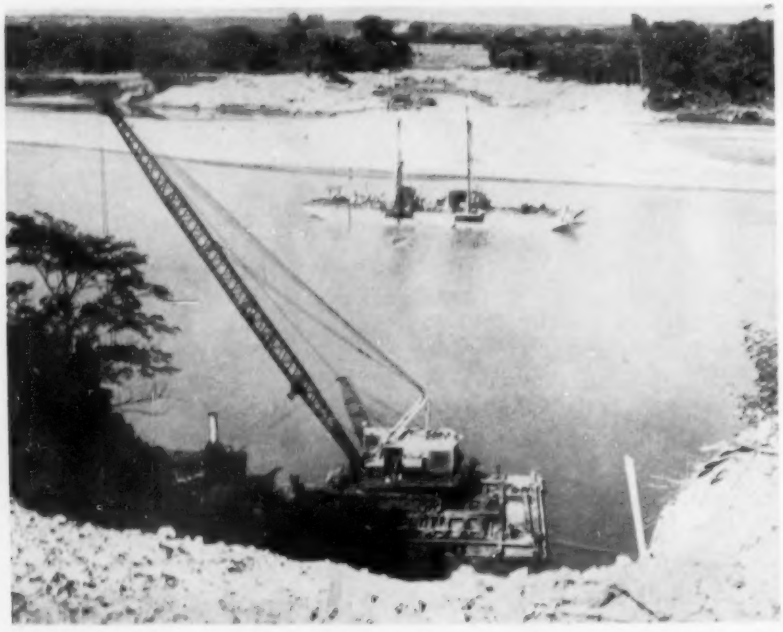
Here's why Northern Natural bets on



COMPARISON of weight of heavy-wall pipe used in river crossings to weight of water it displaces. **Fig. 1.**

Heavy-Wall Pipe for



DREDGE BARGE and shot-hole barge at work in a parallel crossing of the Missouri.

Major River Crossings

Few companies have made wide use of heavy-wall pipe for river undercrossings, most depending on clamps or concrete coating for weight. Northern Natural has had much experience in use of such pipe. Here is why it prefers the thick-wall pipe.

by William B. Haas
Northern Natural Gas Co.

FROM early experiences Northern Natural Gas Co. has felt that heavy-wall, soft-steel pipe is the best answer to getting a good river crossing. The first work done with such pipe confirmed our convictions. It is easier to handle, bend, weld, and coat. It can be pulled into place easier than pipe with river clamps.

We have always felt that where at all practicable it is to a gas company's advantage to investigate each individual stream crossing, giving serious consideration to the advantages and disadvantages of bridges and undercrossings. We have found streams where the bottom is always stable and never subject to scour. Here, an undercrossing is the most practical. We found others where the bottom tended to scour and deepen and the banks remained stable, making a bridge the most practical approach. We found still other streams where either type of crossing would lend itself to the company's advantage. Our early experience with undercrossings indicated that river clamps on normal weight pipe was not necessarily the answer for a good crossing. We felt that good-grade, heavy-wall, soft-steel pipe, properly installed across a stream.

TABLE 1—HEAVY WALL PIPE USED IN RIVER UNDERCROSSINGS

Year, river, and state—	Wall thickness (in.)	Length, miles
1945:		
Elkhorn—Nebraska	0.718	0.369
1946:		
Solomon—Kansas	0.937	0.080
Salt Creek—Kansas	0.937	0.070
Des Moines—Iowa	0.812	0.135
1949:		
West Nishnabotna—Iowa	0.937	0.224
Boone—Iowa	0.937	0.152
Boone—Iowa	0.812	0.154
1950:		
Cimarron—Kansas	0.812	0.459
Cimarron—Kansas	0.812	0.449
Missouri—Nebraska	0.812	0.946
Missouri—Iowa	0.812	0.946
1951:		
Cimarron—Kansas	0.937	0.271
Papillion Creek (2)—Nebraska	0.843	0.145
Platte—Nebraska	0.843	0.909
1952:		
Stevens Creek—Nebraska	0.843	0.080
1953:		
Beaver—Oklahoma	1.250	0.299
Des Moines—Iowa	0.812	0.140
1954:		
Cimarron—Oklahoma	1.250	0.750
Smoky Hill—Kansas	1.250	0.152
Salt Creek—Kansas	1.250	0.049
Solomon—Kansas	1.250	0.099
Boone—Iowa	1.250	0.121
Middle Raccoon—Iowa	1.250	0.060
Des Moines—Iowa	0.843	0.090
Cedar and Maquoketa—Iowa	0.843	0.454
Des Moines and Iowa—Iowa	0.812	0.198
Big Sioux—Iowa	0.812	0.133

would minimize the possibility of losing a crossing.

Excessive moisture in the form of snowfall, during the winter of 1943 and 1944, an early spring thaw, plus abnormal spring rainfall, started an erosion problem on the north bank of our Elkhorn River crossing, jeopardizing operations. World War II limited materials available for increasing the length of the bridge. Being aware that a bridge is readily susceptible to air attack, we gave serious thought to an undercrossing, so we would not have "all our eggs in one basket."

The War Production Board advised us that we could secure some 18-in. Grade A seamless pipe with wall thickness of 0.718 in. early in 1945. This pipe would give us equivalent capacity and could be laid at a sufficient depth and distance from our bridge should the latter be subject to attack by air. The probability of losing the towns and cities north of this crossing would then be relatively remote. Omaha Dredge & Dock completed this project early in 1945, a crossing of a little over 1,900 ft. in length. The line was laid well below the bottom of the river and amply coated with enamel.

We investigated the possibility of laying normal-weight pipe with cast-iron river clamps. But one of the critical items at this time was cast iron.

We have found since making this first installation, that we can secure normalized heavy-wall pipe that is fully X-rayed and meets any pressure requirement we need. When constructing an undercrossing, one likes to know that the installation is the best and safest crossing that can be economically justified. We have also found that this heavy-wall pipe, due to its uniform weight, has sufficient negative buoyancy to insure that it will sink to the bottom should the stream bed become disturbed and turbulent. See Fig. 1.

We have experienced no difficulty over the past 11 years using heavy-wall pipe ranging in diameter from 16 to 30-in. and in wall thickness from 0.718 to 1¼-in. on some 26 stream crossings. This seems to bear out our contentions. See Table 1.

We make a practice of adequately coating all these crossings with enamel, glass-reinforced with an out wrapping of asbestos felt, shielded with some type of rock protection and slatling.

Our specifications for normal river-crossing pipe are as follows:

1. Material:

(a) The pipe will be made from steel plate of structural quality with physical and chemical properties as indicated in (b) and (c) below.

(b) Chemistry:

	Per cent max.
Carbon	0.30
Manganese	0.15
Phosphorous	0.045
Sulfur	0.045

(c) Tensile properties:

Tensile strength, psi.	60,000
Yield point, psi.	35,000
Elongation in 2 in. (%)	25

(d) The steel plates shall be ordered by thickness with a maximum allowable variation of not more than 0.01 in. under the nominal thickness specified (1¼ in.).

(e) Test reports covering both chemical and physical properties of each heat of steel will be furnished and shall comply with the requirements of Paragraph 1 (b) and (c) above.

2. Manufacture:

Preparation. (a) The longitudinal edges of the plate shall be prepared for double-butt welding by the submerged-arc process. The plate shall be properly formed and tack-welded prior to welding. Edges to be welded shall be cleaned of all oil, grease, rust, and scale. If laminations are disclosed in these operations, the plate shall be rejected.

3. Welding:

(a) Longitudinal welding shall be of the double-butt type done by the submerged-arc process using welding rod of suitable chemical composition.

(b) All welding will be done with procedures and operators that have been qualified in accordance with the requirements of Section IX of the A.S.M.E. Boiler and Pressure Vessel Code.

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4. Welding test specimen:

(a) Weld specimens shall be furnished from every 200 lineal feet of pipe or fraction thereof. These test specimens shall be taken perpendicularly across the weld and from the weld approximately in the middle of the specimen. The test specimen shall be flattened and machined to standard rectangular tension test specimen.

(b) All test specimens shall be tested at room temperature.

(c) The test specimens taken perpendicularly across the weld shall show tensile properties not less than those specified for the plate.

(d) If any test specimen shows defective machining or develops flaws not associated with the weld, it may be discarded and another specimen substituted.

5. Radiographic examination:

(a) All longitudinal and circumferential seams shall be radiographically examined to the extent of at least 5 per cent of the linear footage of welded seams. The sections to be radiographed shall be selected at random and shall include sections at the beginning of each run (defined as pipe of the same diameter, wall thickness, and material).

(b) The radiographic examination shall be performed in accordance with requirements of the A.S.M.E. Code for Unfired Pressure Vessels, latest revision as indicated below.

(c) Technique shall be in accordance with Paragraph UW-51.

(d) The acceptability of the welding shall be judged by the requirement of Paragraph UW-52 (d), except that the welding must also meet "standard for porosity" given in the A.S.M.E. Boiler and Pressure Vessel Code Section IX.

(e) The procedure for spot reexamination shall be as given in Paragraph UW-52 (g).

(6) Hydrostatic test:

(a) Each length of pipe will be tested to a pressure of 2,200 psi.

(b) If leaks are found, the defects shall be removed and the area rewelded. Pipe thus repaired shall be retested.

7. Permissible variation in dimensions:

(a) Out-of-roundness shall not exceed 1 per cent of the outside diameter as determined by the difference between the major and minor outside diameter.

(b) The pipe shall be straight subject to a tolerance of ⅛ in. using a 10-ft. straight edge placed so that both ends are in contact with the pipe.

(d) The wall thickness, measured at the ends, shall not be more than 0.010 in. under the specified thickness. Localized (isolated and noncontinuous) reductions in wall thickness caused by noninjurious surface defects may be permitted up to a depth not exceeding 6½ per cent of the nominal pipe-wall thickness.

(e) Specified lengths of straight pipe sections shall not vary by more than ±⅛-in.

8. Lengths:

Except as otherwise specified on the order, the pipe will be furnished in 20-ft. lengths.

9. Finish:

(a) The finished pipe shall be free from injurious defects and shall have a workmanlike finish.

(b) Pipe showing moderate slivers may be machined or ground inside or outside to a depth which shall insure the removal of all included scale and slivers, providing the wall thickness is not reduced below the specified minimum wall thickness. Repair of plate defects by welding shall be permitted but the defect must be thoroughly removed and the welding performed by a welder qualified in accordance with the requirements of Section IX of the A.S.M.E. Boiler Construction Code. Such repair welding shall be ground or machined flush with the surface of the pipe.

THE AUTHOR

William B. Haas is superintendent of pipelines for Northern Natural Gas Co. He is responsible for the operation and maintenance of all transmission and gathering-system pipeline construction, radio, cathodic protection and company-owned telephone facilities. He has been with Northern since 1931. At Purdue University he studied civil engineering and completed his studies at Case Institute of Technology.

In 1931 he began working as chief of field party handling the south half of 26-in. main line for Northern which was being constructed from Mullinville to Clifton. When the line was completed he went to work at Salina, Kans., in the office of Kansas Pipeline Co. In March 1940 he was transferred to Omaha as office engineer and in 1943 was made assistant superintendent of pipelines. He was promoted to superintendent of pipelines in February 1952.

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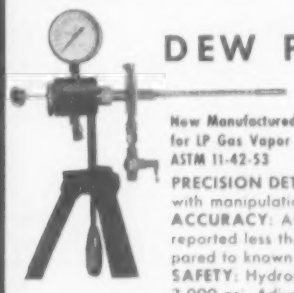

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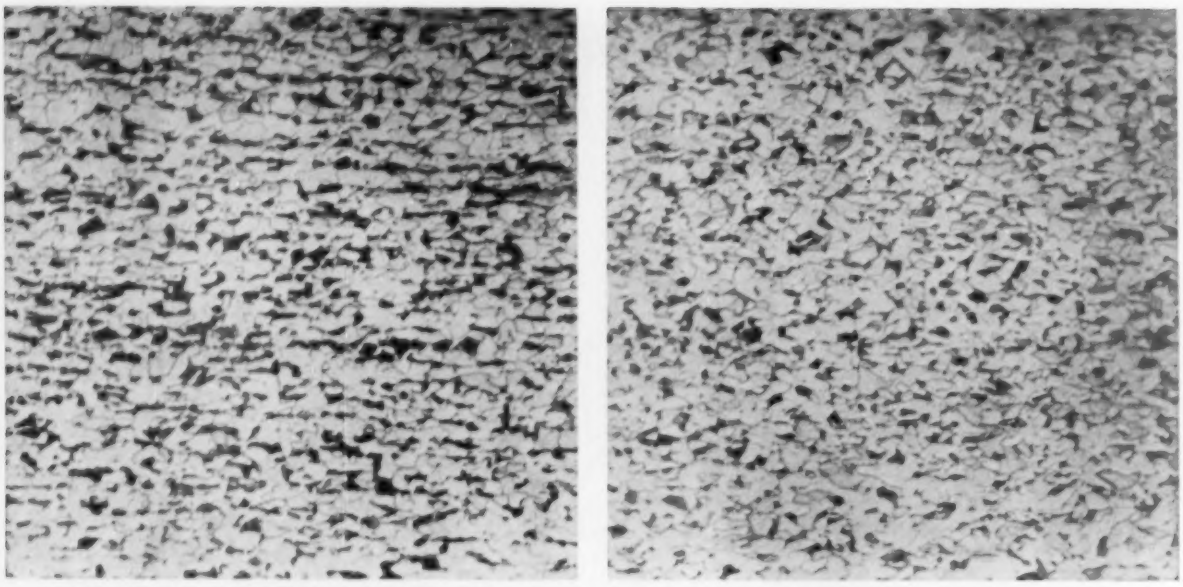


LONGITUDINAL MICRAGRAPHS of cold rolled steel showing presence (left) and absence (right) of banding. Fig. 1.

In-line corrosion-test-coupon method proves best in answering question . . .

Is Your Inhibitor Doing Its Job?

Use of in-line test coupons and a more rigid test method than that specified by A.S.T.M. assure Sinclair of corrosion protection. In testing various methods the authors proved conclusively that surface conditions of the test specimens have a great deal to do with corrosion rate.

by R. H. Meyer
Sinclair Pipe Line Co.
and
D. B. Sheldahl
Sinclair Research Laboratories

An effective method of determining the rate of internal corrosion in a products pipeline must go hand in hand with the use of a corrosion inhibitor. If a rapid means of evaluation is not available, it cannot be determined readily if the amount of inhibitor used is just adequate, inadequate, or perhaps excessive. This is very important as it determines the economic balance of the internal corrosion of the pipe and the effects of the corrosion products on the equipment against the cost of inhibitor.

In products pipelines there are two general methods of internal corrosion control: (1) addition of corrosion inhibitors and (2) dehydration. Control of internal corrosion by adding inhibitor is generally somewhat more economical than dehydration. The high initial cost of dehydration facilities plus a throughput cost per barrel nearly equal to the cost of inhibitor per barrel accounts for the more general use of inhibitors.

The sensitivity of various petroleum products for an inhibitor is usually different. A method of determining the optimum amount of inhibitor required becomes a prerequisite to economic and good use of an inhibitor. The sensitivity of even one specific petroleum product from a given refinery has been shown to change considerably over a period of years, emphasizing even more the need for a good but simple evaluation method.

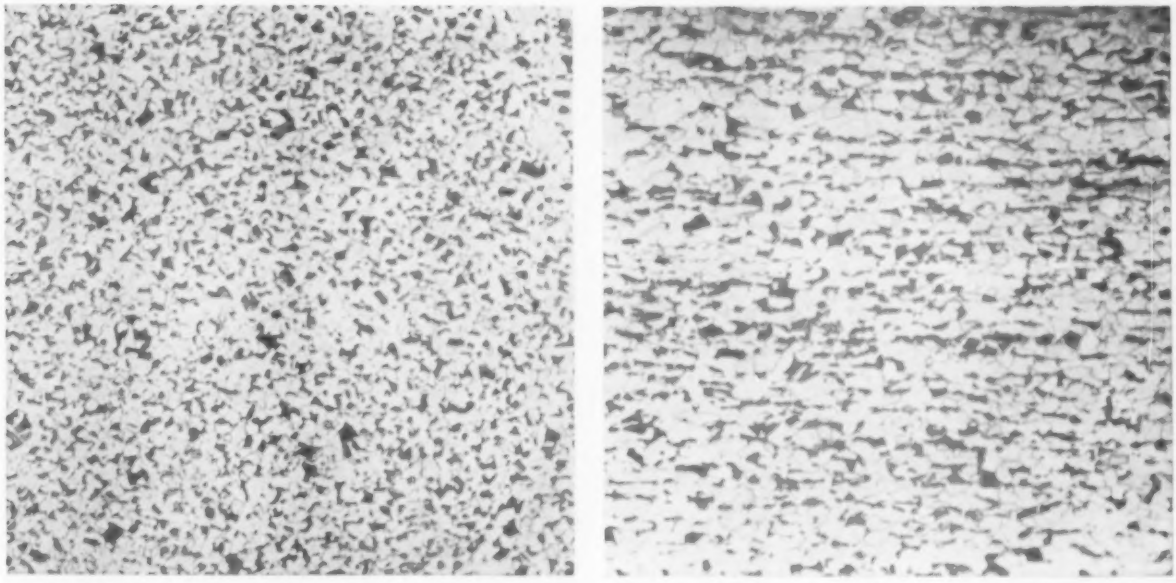
Oil-Soluble Inhibitor Used

Oil-soluble and water-soluble inhibitors are the two types of inhibitors currently used in products pipelines. The use of a water soluble inhibitor has the following disadvantages:[1,2]

1. The inhibitor is injected into the pipeline in water solution.
2. The addition of water in cold regions may result in freezing the line shut.
3. The water must be separated from the product at the terminus requiring additional equipment.
4. The inhibitor must be added at periodic intervals along long pipelines if adequate protection is to be achieved. No protection is afforded to facilities other than the pipeline.
5. The frequency of scraper runs must be higher if throughput efficiency is to remain constant.

Because of these disadvantages, an oil-soluble inhibitor, RD-119, was developed for use in Sinclair products pipelines.[3] For over 10 years this oil-soluble inhibitor has been used in all Sinclair products. It is very simply blended into products at the refinery and therefore provides corrosion protection to all subsequently contacted equipment.

The requirements for an inhibitor-evaluation method were different for the refinery and the pipeline locations. At the refinery, a rapid laboratory evaluation was desired, while at pipeline locations a simple method not requiring



MICROGRAPHS of cold rolled banded steel. Traverse section (left) fails to show banding which is shown in longitudinal section. Fig. 2.

laboratory facilities was desired. The two methods selected, however, both use polished-metal test coupons.

Modified rust tests . . . A modification of the A.S.T.M. D-665 test, "Evaluation of Rusting Characteristics of Steam Turbine Oils in the Presence of Water," (procedure A) is often used to evaluate product-pipeline corrosion inhibitors.[1,3,4] Sinclair modifies this procedure by shortening the test to 3½ hours and reducing the temperature to 100° F. This modification has been used for several years to control the corrosion-inhibitor concentration in products leaving the refineries in spite of the occasional occurrence of erratic results. However, on one series of tests anomalous results were obtained which were serious enough to warrant further investigation.

After running repetitive tests on a number of test rods, it was found the rods could be segregated into two groups based on the appearance and type of rust as well as on weight losses. In each group the data were more consistent than for the whole set of rods and one group of rods gave considerably more consistent data than the other. Since this appeared to be a difference in steel, a metallographic examination of test rods from each group was made. Both transverse and longitudinal sections were examined and it was found, from longitudinal specimens, that the rods fell into two groups, one showing a homogeneous structure and the other a banded, nonhomogeneous structure. These groups corresponded exactly with the grouping based on test results, with the banded structure showing the greatest divergence of results.

Effect of metallurgical banding . . . Our specimens conformed to A.S.T.M. specifications but a study of the section on "Test Specimens and Their Preparation" in the D-665 test shows that there is no control relating to homogeneity of metal structure. The A.S.T.M. steel designation A-108, "Cold Finished Steel Bars and Shafting," referred to in the D-665 test, will permit use of steels with different microstructures. These steels may be either rimmed or killed. Rimmed steels are apt to have alternate bands of high concentrations of manganese and carbon aggregates. Radd and McGlasson have found that two steels having the same nominal A.I.S.I. analysis but having different microstructures in respect to banding and nonbanding have different corrosion rates in acids.[5] Shock and coworkers have shown that the amount and form of iron carbide present in steel affects the corrosion rate.[6] Evans has found that to obtain even distribution of corrosion a test specimen of uniform composition is required.[7]

Banding cannot be detected by metallographic examination on a plane perpendicular to the center line of the rod but is readily observed on etched surfaces parallel to the axis. Fig. 1 shows longitudinal sections of two steels, one of which is banded. Fig. 2 shows banding in a longitudinal section which would not show up in a transverse section.

A series of corrosion tests were made to determine the effects of banded versus nonbanded steel. Corrosion rates were quickly and easily determined by running a 24-hour turbine test at room temperature using Chicago tap water as the test liquid rather than the usual hydrocarbon-water mixture. By this means differences in corrosion rates were accentuated. Data from these water tests were later checked in the usual hydrocarbon-water mixture and the effect of the variables, while different in degree, was similar in each case.

Results in Table I show that corrosion rates with banded steel test rods were more variable than with homogeneous steel rods. The amounts of corrosion are less with banded steel.

It is evident that banded steel rods give less-reproducible corrosion rates than the homogeneous specimens.

Having found that A.S.T.M. specifications for steel test rods were not sufficiently stringent we decided to check into the A.S.T.M. directions for surface preparation of the test rods.

Effect of surface roughness . . . Following specimen preparation directions in the A.S.T.M. procedure does not nec-

TABLE I—TURBINE TEST CORROSION RATES ON BANDED AND NONBANDED S.A.E. 1020 STEEL IN CHICAGO TAP WATER

(Each figure is an average of 6 or more tests.)

Type of steel—	Corrosion rate, mdd.*			Standard deviation,† per cent
	Average	Minimum	Maximum	
Nonbanded cold roll	215	193	240	7.2
Banded cold roll	166	106	195	18.3

*Milligrams per square decimeter per day. †Determined by method of Davis.[8]

essarily insure a uniform surface finish on all test rods. The final surface roughness will depend on a number of factors including length of time the polishing paper is held in one place on the specimen, the amount of pressure applied to the paper, and the time consumed in polishing.

We have found that the degree of roughness as measured by a profilometer has a marked effect on the corrosion rate. However, such surface roughness is by itself not a criterion of surface condition or the amount of corrosion to be expected in a turbine test. The manner in which the surface roughness is obtained is critical. We have found that a surface roughness of 35μ, obtained by polishing with 100-grit silicon carbide abrasive cloth is easily obtained and gives reproducible corrosion rates on turbine test rods.

Table 2 shows the differences in corrosion rate obtained by polishing a homogeneous steel to different surface finishes with 100-grit silicon carbide abrasive cloth.

The same 24-hour, room-temperature test in Chicago tap water was used to determine the effect of surface finish.

The smoother (12μ) coupons show less corrosion and less reproducibility. Evans as well as King and Rau have found that, on ground surfaces, corrosion occurs first on the major abrasion lines.[7,9] Since a rougher surface would have more major abrasion lines the higher corrosion rates on rougher specimens would be expected.

Effect of different abrasives . . . Table 3 shows the effect of different abrasives on the corrosion rates of rods polished to the same surface roughness.

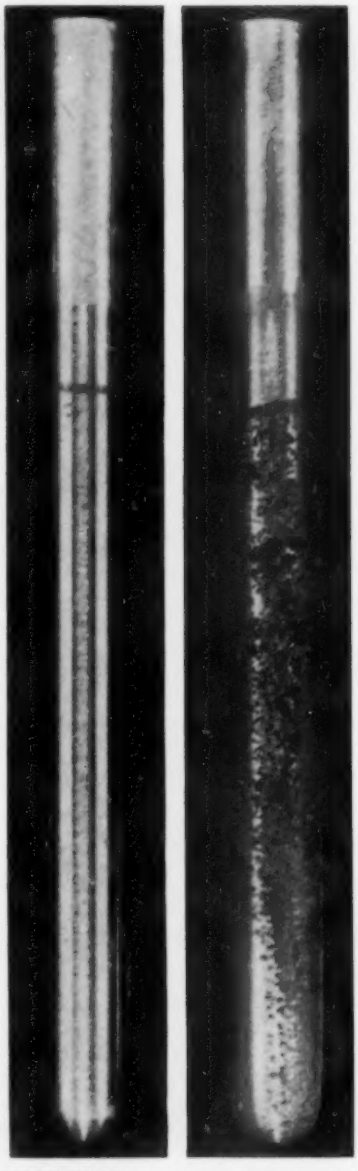
The difference in results between the two abrasives is probably due to different surface profiles on the test specimens caused by the difference in hardness between garnet and silicon carbide. The profilometer measures only the maximum distance between peaks and valleys on the specimen but gives no further indication of surface condition.

These data show that steel specimens of uniform, nonbanded microstructure, polished with 100-grit silicon carbide abrasive cloth to a surface roughness of 35μ give more reproducible results than any other combination of variables tested. It is interesting to note that additional test work on a surface finish of 42μ showed no advantage over a 35μ surface.

When the effects of banding and surface preparation had been determined in the tap-water corrosion test it was necessary to repeat them in the regular turbine test using 90 per cent hydrocarbon and 10 per cent of either distilled or synthetic sea water. Corrosion-inhibitor requirements for turbine oils were determined using nonbanded S.A.E. 1020 steel with both 12μ and 35μ surfaces obtained with 100-grit silicon carbide cloth.

In the distilled-water test two to three times as much inhibitor is required with a 35μ surface than with 12μ. Using synthetic sea water there is about a 100 per cent difference in inhibitor requirement.

Fig. 3 shows the amount of rusting that can occur at the same inhibitor concentration when similar rods are polished to different surface conditions with the same abrasive.



DIFFERENCES in corrosion rate caused by different surface finishes. Rod at right has 35μ surface; that to the left, 12μ. Fig. 3.

Standardized Procedure

As a result of these investigations, Sinclair Refinery laboratories and the research laboratory standardized their testing procedure to use rods made only from uniform, nonbanded, cold-rolled, S.A.E. 1020 steel. These specimens are finished to a surface roughness of 35μ (as measured by a profilometer) using 100-grit silicon carbide abrasive cloth. Since the inauguration of this procedure few, if any, discrepancies have oc-

THE AUTHORS

R. H. Meyer is a senior engineer for Sinclair Pipe Line Co. at Independence, Kans. He is handling liaison with Sinclair Research Laboratories, Inc., covering pipeline research and development activities. In 1949 he received a B.S. degree in chemical engineering from Kansas State College. For 1 year he was with Phillips Petroleum Co. in its research and development department. Then for 2 years he was with the oil-movement department of Sinclair and has since been a member of the engineering department.

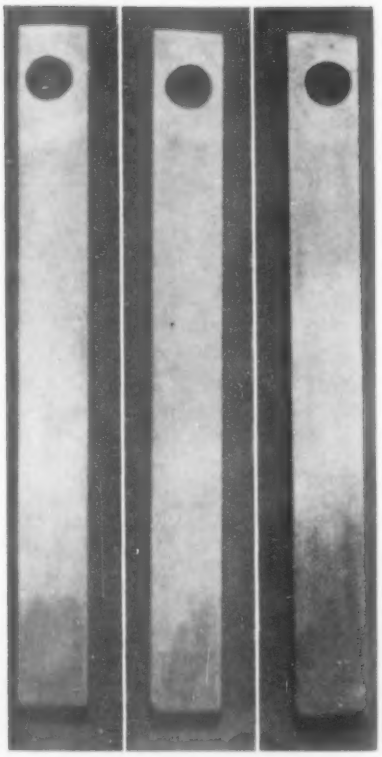
D. B. Sheldahl received his B.S. degree in chemical technology from Iowa State College in 1936. Since then he has been employed by Sinclair Research Laboratories in various capacities. He has been a member of the corrosion division since it was organized in 1948, specializing in corrosion-inhibitor testing.

TABLE 2—CORROSION RATES OF NONBANDED S.A.E. 1020 STEEL WITH DIFFERENT SURFACE ROUGHNESS

Surface roughness:	Corrosion rate, mdd. Average	Minimum	Maximum	Standard deviation, per cent
35μ	215	193	240	7.2
12μ	153	100	193	24.4

TABLE 3—EFFECT OF DIFFERENT ABRASIVES ON THE CORROSION RATE OF NONBANDED S.A.E. 1020 STEEL

Abrasive (100 grit)—	Surface roughness	Corrosion rate, mdd. Average	Minimum	Maximum	Standard deviation, per cent
Silicon carbide	35μ	215	193	240	7.2
Garnet	35μ	149	105	188	19.5
Silicon carbide	12μ	153	100	193	24.4
Garnet	12μ	127	32	183	43.8



IN-LINE test coupons installed at receiving and terminal points. Fig. 4.

curred among our various laboratories or within any single group of repetitive tests.

The method used to obtain our specimen surface is very simple. After a rough polishing to remove gross defects, the final polish is made by holding a 3 by 5-in. piece of abrasive cloth in the palm of the hand against the rotating test rod. The abrasive is lightly held and is constantly moved back and forth on the axis of the rod until the surface appears visually uniform. During this final polish very little wear on the abrasive should occur. This procedure, simple as it is, gives remarkably uniform surfaces. The variations in surface roughness are of the order of $\pm 3\mu$.

In-Line Test Method

To test the corrosion-inhibitor effectiveness in the pipeline, polished-steel test coupons, approximately 5 by ½ by ⅛ in., are installed in the products stream at receiving points and terminals. These test coupons, shown in Fig. 4, are left in the line for a continuous period of 1 month. The coupons are very sensitive and show exactly the same effects from metallurgical banding, degree of roughness, and kind of abrasive used in polishing as

TABLE 4—CORROSION INHIBITOR REQUIREMENT IN TURBINE OILS

	Minimum inhibitor requirement, p.p.m.*			
	Using distilled water Surface finish		Using synthetic sea water Surface finish	
Inhibitor:	35μ	12μ	35μ	12μ
A	30	10	200	100
B	100	50	350	200

*Amount of inhibitor required to give no more than two or three specks of rust on the test rod.

do the test rods in the modified turbine type of test.

The test coupons are installed in the pipe through a special device for use without shutting the line down or attached to a removable flange in a portion of the pipeline that can be bypassed during installation of the coupon. Fig. 5 illustrates the 2-in. pipeline tap valve, and stuffing box currently used for installing test coupons. The coupon is hooked to a swivel snap

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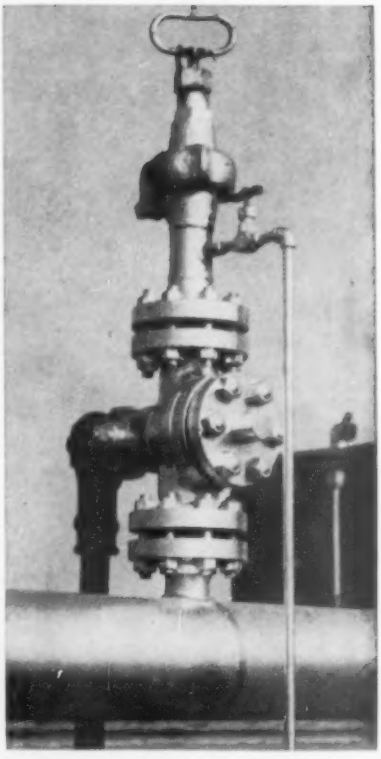
attached to a chain fastened on the movable stem. This coupon can also be attached directly to the end of the drill rod if it is desired to hold the coupon in a fixed position. The raising and lowering of the stem positions the device for installation or removal of the coupon. In the latter case, the valve is then closed, the coupling broken and the coupon removed. Two companies have devices commercially available to install coupons in lines under pressure.

Preparation of coupons . . . The test coupons are prepared by Sinclair Research Laboratories, Inc. Discrepancies between tests have been minimized by selection of steel, abrasive cloth, and standardizing surface roughness. A cold-rolled S.A.E. 1020 steel is used. Coupons are polished to a surface roughness of about 35μ using a belt sander. Belts are 100-grit silicon carbide cloth. Belts are used for grinding only a limited number of coupons to give reproducible surface finish. During grinding, coupons are conveniently held by powerful permanent magnets. This also prevents any moisture from reaching their surfaces during handling.

After surface preparation, the coupons are individually packaged in an envelope treated with vapor corrosion inhibitor. The envelope shows the date of coupon preparation and has blank spaces for dates of installation and removal, location, and any pertinent remarks required at the point of use. Because the ground surface is very sensitive to moisture, extreme care is exercised not to touch the coupons with bare hands or to allow moisture to come in contact with the coupons during the installation and removal from the line. After removal from the pipeline, the coupon is placed in the vapor-corrosion-inhibited envelope in which it was originally shipped, and returned for grading.



ASSEMBLY USED for the installation of in-line test coupons. Fig. 5.

Method of Grading Coupons

The grading of the coupons is done at the laboratories once a month on a visual basis. The weight loss due to corrosion is often so slight compared

TABLE 5

Rating	Per cent of surface corroded
A	None
B++	Less than 0.25
B+	0.25 to 5
B	5 to 25
C	25 to 50
D	50 to 75
E	75 to 100

20-foot power-augering equipment operated by CSI.

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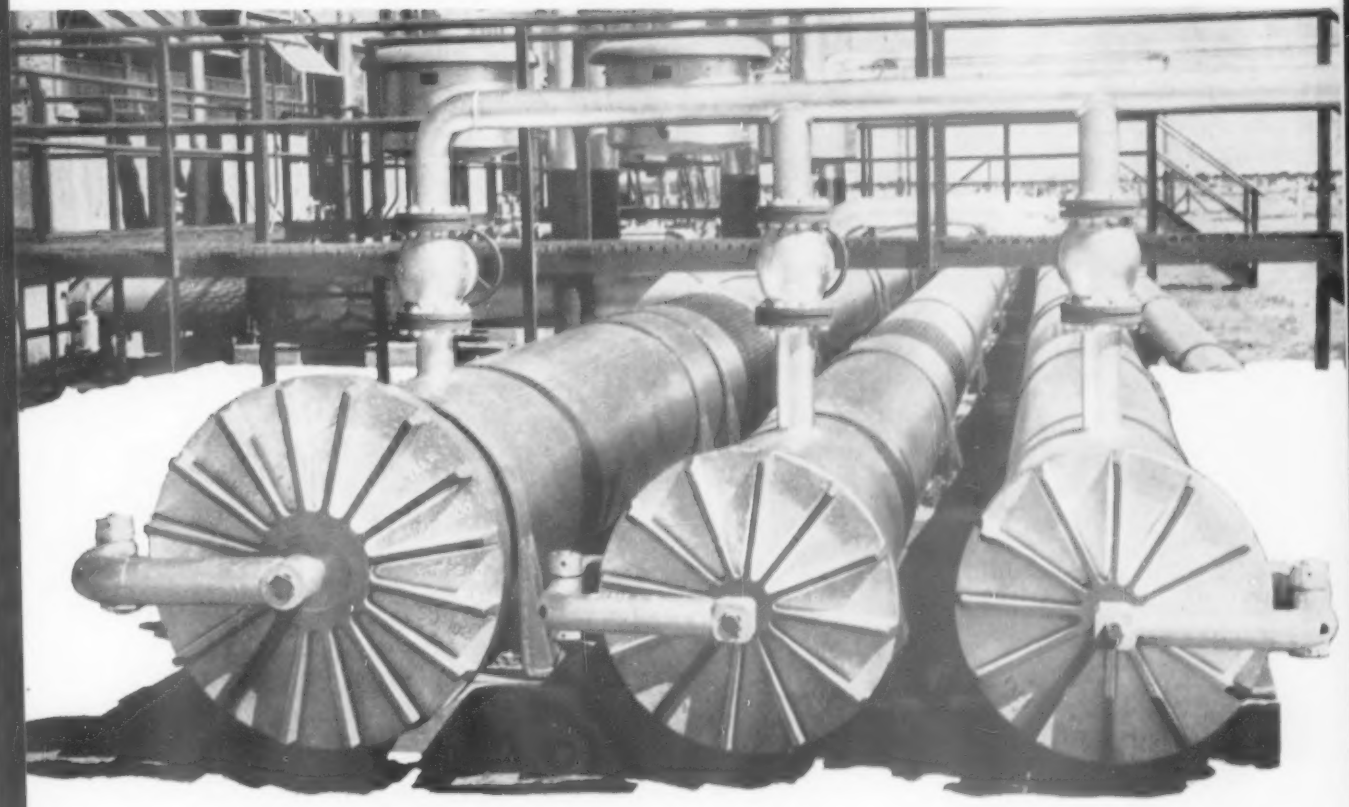

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to losses resulting from wearing or peening while in the pipeline that it might not be a good criterion of the amount of corrosion. Table 5 shows the amount of corrosion in percentage of surface corroded. In addition, the corrosion is described as very very light, very light, light, medium, heavy, and very heavy.

Ratings of B+, B++ and A are considered to be an indication that no significant amount of internal corrosion is occurring in the pipeline. A coupon showing over 5 per cent rusted area indicates inadequate corrosion protection at the location in which the coupon was used. That location then receives special study and attention to pin point and eliminate the cause of corrosion. The dividing line of less than 5 per cent corroded or more than 5 per cent corroded has been established after a number of years' experience as the point at which it is necessary to add extra inhibitor to provide adequate protection.

Many factors in the use of the in-line test-coupon method, which is an extremely severe test, have been tested to determine their significance. It has been determined that it makes no difference if the coupon is placed in a fixed holder, or allowed to swing freely at the end of a chain. Vapor - corrosion - inhibited paper envelopes used for shipping and handling offers adequate protection without affecting the sensitivity of the coupon to corrosion in the pipeline.

These specially treated envelopes do not in any way interfere with, limit, or change the results of the test method. The reproducibility of this test under known conditions is very reliable. The correlation between this test and the modified turbine type of test, the accelerated laboratory test, has been proved by experience to be excellent.

Locations of Test Points

To obtain an accurate evaluation of the effectiveness of the corrosion inhibitor, test-coupon installations are maintained at input points, certain stations, and certain terminals. The point of installation in the pipe is chosen so that it is in a position of the line that is always active unless the whole line is inactive and where a typical product stream surrounds the test coupon at all times. Table 6 is an example of a corrosion-test-coupon evaluation report on the effectiveness of RD-119 in one of our products lines over a period of time. Occasional erratic results sometimes occur. Any significant difficulty, however, results in a change of trend and is readily apparent.

Other methods of evaluation of inhibitor effectiveness have been tested but do not compare in simplicity or ease of interpretation of results with the test-coupon method. The frequency of scraper runs required, the frequency of strainer cleaning, the change in C factor, and the change in the amount of sediment and corrosion product in the pipeline all give indications of inhibitor effectiveness.[1 2 3] These methods may all be affected by variation of operating procedures and conditions to such an extent that it is extremely difficult to interpret the data obtained from them.

A segment of pipe, internally polished, has been tested and gives results comparable to the test-coupon method. The disadvantages of the pipe-segment method are difficulty in preparation, handling, and cost. The initial cost of an installation for such a segment is considerable.

Product samples taken at points along the line and tested by the turbine type of rust test give a very satisfactory evaluation covering the period of time while the sample was collected. The expenses and effort required are, however, much greater than for the test-coupon method.

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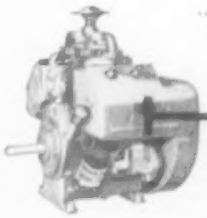

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TABLE 6—INSPECTION DATA ON TEST COUPONS SHOWING CORROSION RATING AFTER EXPOSURE FOR 1 MONTH IN MECHANICSBURG DISTRICT OF SINCLAIR PRODUCTS PIPELINE

Month strip exposed—	Chelsea (east line)	Chelsea (west line)	Schaeffers-town	York	Baltimore	Washington	Jacks
1955:							
July	A	A	A	A	B	C	A
August	A	A	A	A	B+	A	A
September	B+	B+	A	A	B+	B	A
October	A	A	A	A	B	C	A
November	A	B+	A	A	B	B+	A
December	A	B+	A	A		B+	A
1956:							
January	A	A	A	A	A	A	A
February	A	A	A	A	A		A
March	A	A	A	A	B+	A	A
April	A	A		A	A	A	A
May	A	A		A	B+		A
June	A	A	A	A	B+	B+	A

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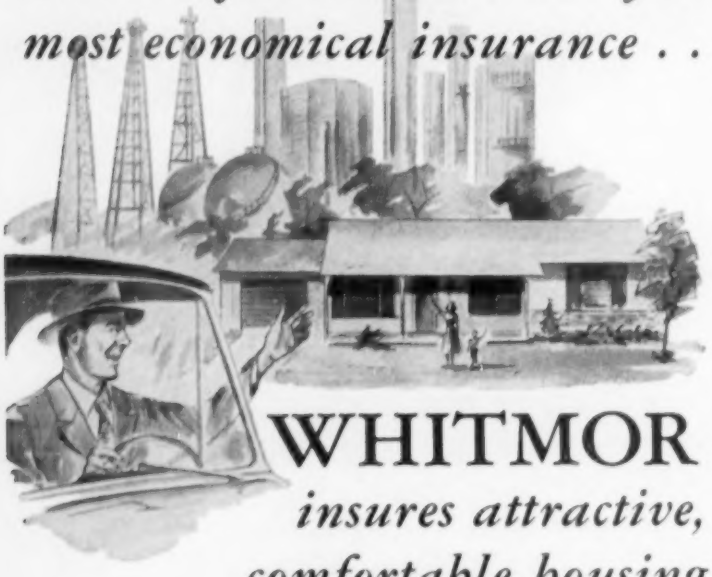

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Conclusions

After 10 years of actual experience of evaluation of effectiveness of an oil-soluble inhibitor, the in-line corrosion-test-coupon method has proved to be the most satisfactory method. The use of the modified turbine type of rust test in the laboratory makes it certain that products delivered to the pipelines contain enough corrosion inhibitor to maintain a high level of internal corrosion control.

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"Yeah, but you ain't draggin' these number twelves of mine through th' sand."

The HOW and the WHY of SURGE PROTECTION

A. C. Smith
Mid-Continent Pipe Line Co.

Using air-type chambers on the suction side and bladder-type dampeners on the discharge side of reciprocating pumps has proved the most economical way to control pipeline surges for Mid-Continent. The author explains surge phenomena, ways of detecting surge, and methods of combating it.

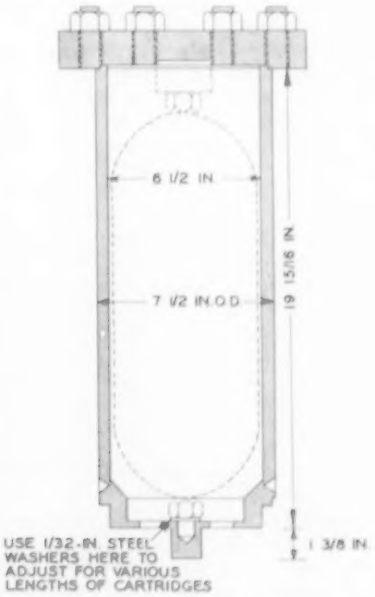
PULSATION and pressure surge, long a serious pipeline operating problem, and the origin of much financial loss, may now be solved economically. Due to the stimulus of increasing competition within the industry since 1945, it is now possible virtually to eliminate or satisfactorily control the effects of pressure surge by the proper selection and installation of pulsation dampeners or suction surge chambers, or both.

Surge, what is it? . . . The flow from reciprocating pumps is pulsating and is found wherever reciprocating pumps are used. Surge is another manifestation of the familiar "water hammer" effect sometimes noticed when closing a flowing water faucet. It has long been known that sudden stopping of the flow of fluid in a pipe will result in a material pressure increase within the pipe. When this pressure rise becomes excessive, serious damage may result to property and life.

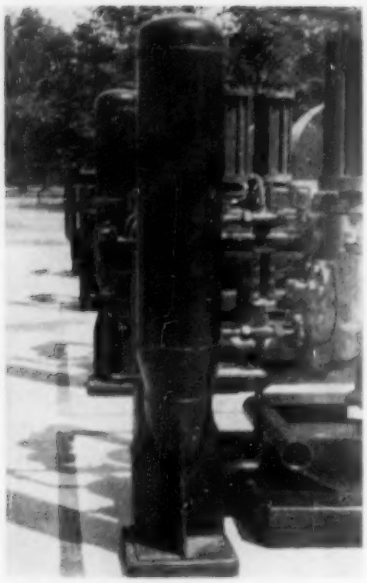
Pressure surge is essentially the reaction due to changes in the velocity of liquid flowing through the pipeline system. It occurs most frequently, and with greatest intensity, when reciprocating pumps are connected to main transmission lines through pipe manifolds which produce frequent and abrupt fluid velocity changes (including directional changes). Installations which include small pipe of varying sizes, numerous bends and turns, and valves with restricted ports are most conducive to pressure surge and vibration.

Failure properly to anchor the pipe manifolds may seriously aggravate vibration problems. The extremely high fluid velocities associated with small-diameter pipe from pumps to manifold is very undesirable. Whether the pumps are operated at high or normal speeds, the writer has always found abrupt fluid velocity changes associated with serious cases of pressure surge or damaging vibration. These are seemingly the combination of factors which amplify the pulsating pressure surges of the pump to damaging proportions.

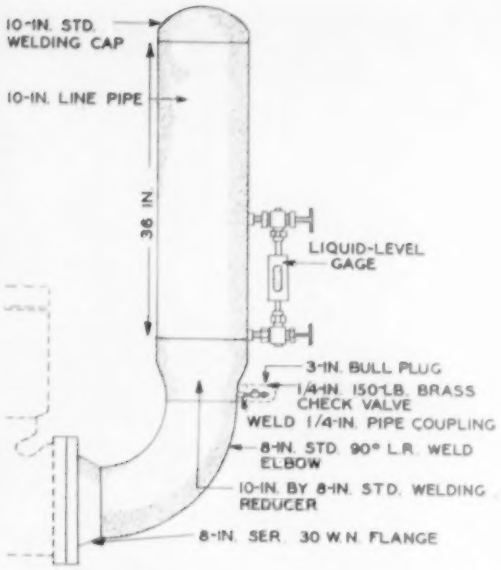
PULSATION DAMPENERS mounted on discharge side of piston pumps. Fig. 1.



DRAWING OF DAMPENER, showing internal bladder. Fig. 2.



AIR CHAMBERS installed on suction side of pump. Fig. 3.


10-IN. STD. WELDING CAP
10-IN. LINE PIPE
36 IN
LIQUID-LEVEL GAGE
3-IN. BULL PLUG
1/4-IN. 150-LB. BRASS CHECK VALVE
WELD 1/4-IN. PIPE COUPLING
8-IN. STD. 90° L.R. WELD ELBOW
10-IN. BY 8-IN. STD. WELDING REDUCER
8-IN. SER. 30 W.N. FLANGE

DRAWING OF SUCTION air chambers such as those used by Mid-Continent. Fig. 4.

What causes it? . . . The water hammer effect is orginated in reciprocating pumps by the sudden increase or decrease in velocity given to the fluid by the action of the piston. During the discharge stroke the piston starts with a zero-forward velocity increasing to a maximum at approximately midpoint of travel. The velocity then decreases to zero at the end of the stroke. The cumulative effect of these impulses repeated many times at regular intervals, in conjunction with undesirable piping or faulty valve action, causes sharp momentary pressure waves to travel through the fluid at approximately four times the velocity of sound in air.

When the frequency of these constant pulsations approaches the natural frequency of the pumping system, they are magnified to very high resonating pressures, resulting in excessive and damaging vibration of the pumps and manifolds. The reverberations thus produced cause a heavy impact on the walls of the pipe, pump fluid cylinders, and valves, which sometimes results in rupture of the pipe or failure of mechanical equipment. The economic results are reflected on the profit-and-loss statement in reduced current profits and on the balance sheet as reduced ownership.

Better Surge Control

Surge control has received special emphasis during the past 10 years, as a result of intense competition within the pipeline industry. This situation has been reflected to the pump manufacturers in increased demands for pumps of higher pressure, speeds, volumes, and decreased pump weight. To satisfy these demands and to offset the competition of other types of pumps, the operating speeds of most reciprocating pumps have been increased 45 per cent or more. The operating speed of the average 10-in. power pump has been increased from 54 s.p.m. to 80 s.p.m. or more, if required. Also, pipeline operators began to design and install "aboveground" manifolds. Resonance is most likely to occur with high-speed pumps; and the shorter lengths necessary to amplify these pressure waves are usually found in such manifold designs.

The economic advantages of these two developments were too valuable to be discarded; consequently, the pressure-surge problem demanded a satisfactory solution. This problem has been solved by mutual effort and pump operators can now be assured of relief at reasonable cost.

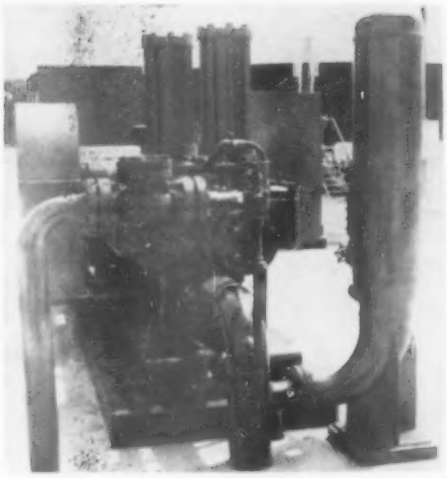
Several types of desurgers and pulsation dampeners are available. Consequently, the question arises as to whether it is better to attempt to eliminate the effects of surge, or to control the pulsations from which the surge originates. The writer's experience has proved rather conclusively that pulsation dampeners are the most satisfactory and economical solution of the problem, but only when properly located. Pulsation dampeners eliminate the many problems common to desurger applications.

Keep surges from discharge . . . The results of a long series of tests by trial and error seem to prove the wisdom of controlling the surges before they reach the discharge manifold where they are greatly magnified by factors very difficult to control or eliminate.

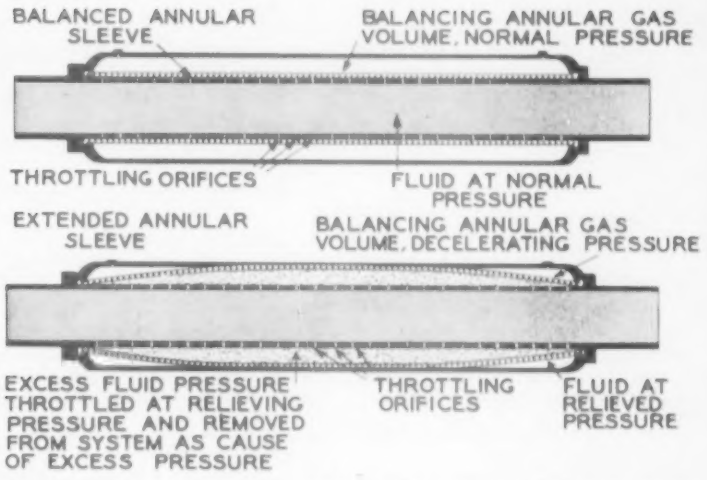
Power pumps have definite operating characteristics which cannot be materially changed. Consequently, these pulsations will occur at all speeds, pressures, and volumes. They become most intense at discharge pressures from 750 psi. upward. In this pressure range a pump will often operate with severe pounding and eventual damage to the machinery or rupture of the manifolds and discharge lines.

Each type of power pump has certain flow and acceleration characteristics which may be modified to some extent by details of design, but are not changed by the piping or other features of the remainder of the pumping system. A direct-acting steam pump could adapt itself to some extent to the characteristics of the entire pumping system because of the cushion effect of its steam cylinders. A power pump has no such flexibility and labors to make the flow of its entire system correspond to its particular flow pattern, except where cushion chambers are used on both the suction and discharge of the pump. While the flow pattern of the pump cannot be changed, its effect on a given piping system is subject to control within practical operating limits. Pulsation dampeners give to the power pump virtually the same cushioning advantages of the direct-acting steam pump, when properly located and installed.

"Surefire" control method . . . A long



SURGE CONTROL on both suction and discharge of pumps are the practical answer to surge problems. Fig. 5.


BALANCED ANNULAR SLEEVE
BALANCING ANNULAR GAS VOLUME, NORMAL PRESSURE
THROTTLING ORIFICES
FLUID AT NORMAL PRESSURE
EXTENDED ANNULAR SLEEVE
BALANCING ANNULAR GAS VOLUME, DECELERATING PRESSURE
EXCESS FLUID PRESSURE THROTTLED AT RELIEVING PRESSURE AND REMOVED FROM SYSTEM AS CAUSE OF EXCESS PRESSURE
THROTTLING ORIFICES
FLUID AT RELIEVED PRESSURE

DESURGERS have not proved completely satisfactory. Top view shows desurger with normal line pressure; in bottom view sleeve gives to relieve line pressure during surge. Fig. 6.

series of field tests by Mid-Continent Pipe Line Co. has verified the practical application of certain types of pulsation dampeners for pipeline service. Consequently, our company has adopted this method as a standard and the units are now in service on most of our mainline pumps. (See Figs. 1 and 2.) Our standards specify two of the pulsation dampeners to be installed on the fluid cylinder of each 10 or 12-in. duplex power pump. In addition, we specify the installation of an air chamber on the suction chamber of each of these pumps. (See Figs. 3 and 4.) The pulsation dampener and the suction cushion chamber must be used together if the best results are to be obtained.

In the past many operators plagued with damaging surge and vibration problems have resorted to frequent and expensive piping and manifold revisions, often with unsatisfactory results. Our test proved that we could control surge pressures and vibration consistently and effectively, without such expensive revisions, by installing pulsation dampeners and suction surge chambers as above described. In our operation this has proved to be a sure-fire method. We have not resorted to any expensive manifold revisions, nor failed to satisfactorily control surge in a single instance, since adopting this method as our standard.

Cost of Surge Protection

To the harried operator whose cost of operation is being materially increased by surge and vibration damage, the question of what can be done and at what cost becomes a matter of urgency. Is it best to attempt elimination of the vibration and surge or to dampen the pulsations from which the surge originates? During the past 18 years the writer has failed to satisfactorily solve a single vibration or surge problem by use of "desurgers."

The pulsation dampener method is not a perfect solution. Nor is it to be assumed it will produce a nonpulsating continuous flow similar to a centrifugal pump; however, dampeners will control the effects of pulsation and surge within practical operating limits. The installed cost of dual pulsation dampeners and a suction surge chamber combination is approximately $600 per pump. It should not be assumed that entirely satisfactory results can be obtained without both pulsation dampeners and suction surge chambers. Dual pulsation dampeners are approximately 70 per cent more effective than a single pulsation dampener. Records indicate the addition of more than two pulsation dampeners does not materially increase their over-all effectiveness.

The location of the pulsation dampeners and suction surge chambers, with relation to the pump, is of primary importance, and may mean the difference between success and failure. In contrast, field tests of different types of desurgers, located at many and various places in the piping system, afforded varying degrees of relief, none satisfactory from the standpoint of the practical operator. Drawings of the desurger type of surge controllers are shown in Fig. 6.

Solving Surge Problems

The solution of surge problems begins by surveying and eliminating as many obvious contributory causes of surge as possible. Whenever a confined liquid is moving at any velocity, anything that will cause it to accelerate or decelerate rapidly will cause trouble.

Probably the most common cause of surge is inadequate suction conditions or failure to maintain adequate suction pressure at the intake nozzle of the pump. Reciprocating pumps are particularly susceptible to shock and vibration if operated at normal or high speeds without a flooded suction or pressurized suction inlet. Bear in mind that adequate suction conditions do not always exist, even though the free liquid level in the tank may be well above the level of the pump inlet. Small suction lines, which restrict fluid flow to the pumps, at the maximum velocity of the flow cycle are the most common cause of pump shock and consequent vibration.

Another unnecessary cause of hydraulic shock in reciprocating pumps is failure properly to maintain clearances between crosshead pins and bushings or between the crankshaft and its bearings. A great deal of preventive surge protection can be achieved through the correct application of pumps, pump valves, and other devices that can affect or interrupt the continuity of fluid flow through the pumping system. Failure to select reciprocating-pump valves and springs properly upon the basis of speed and liquid being moved may also accentuate the surge problem.

For high-speed operation, heavier valve springs are indicated to prevent shock caused by valve movement lagging behind piston movement. On the other hand, if the valve springs are too stiff, or valves too heavy for the suction pressure available, the pump may not fill properly at any speed. The results may be serious.

If local remedies do not solve the

"Once begun, surges may persist for a while thereafter, even though speed variations may have changed the phase relationships . . . Solution is to install effective pulsation dampening equipment on each pump."

surge problem it is advisable to seek the advice and guidance of the pump or pulsation-dampener manufacturers.

Detecting surge . . . Most of the low-frequency pipeline surges produced by reciprocating pumps can be detected audibly and sometimes visually (by the movement of unanchored sections of pipe). The most satisfactory method of accurately measuring the pressure variation, however, is by means of a cantilever type of engine indicator with suitable calibration and spring tension. By taking an indicator card, the frequency and amplitude of the pulsations can be graphically represented.

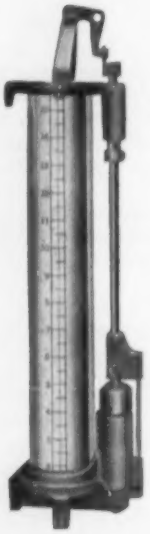
In the absence of an engine indicator, a Bourdon type of pressure gage may be inserted at various locations in a piping system to measure the relative severity of the low-frequency pressure variations. These gages will be of little value for measuring the very high-frequency pulsations, however. Only the most sensitive and exacting engine indicator will be able to record these minute fluctuations. The small amplitude should not be regarded as grounds for minimizing the destructive effects of these rapid surges. Numerous cracked pump fluid cylinders, broken drive shafts, and bearings offer convincing testimony to the contrary.

Unlike simple water hammer which can be calculated reasonably accurately, pipeline surge is not susceptible to exact mathematical analysis. Momentary pressure surges due to shock have been produced well in excess of prediction formulas. For example, with main-line pressures of 500 psi., surge pressures of 1,500 psi. are not uncommon. Still higher pressures must occur for steel pump cylinders are occasionally cracked which have successfully withstood static test pressures of 3,500 psi. Crankshaft bearings, crosshead bearings, and main herringbone driving gears have all been destroyed by the powerful force of hydraulic shock. The conclusion is that these tremendous pressure buildups are produced by amplified oscillations which are directed back toward the pump from some reflecting point in the pipeline. Such a likely point might be a sudden increase in pipe area somewhere down line.

If the oscillations happen to be in phase with the pump impulses, resonance occurs and the peak pressures are compounded. If the fluid column breaks, the forces of inertia may then strengthen the already high surge, and momentary pressures to almost any magnitude are possible. If there are no points of reflection, however, the initial impulses die out by internal pipe friction and cause no trouble in excess of their original severity.

Avoid abrupt size changes . . . An impulse "reflector," such as mentioned above, almost always consists of a sudden enlargement or sudden contraction in the size of the discharge piping. Since in almost every instance the discharge line from one or more pumps ends in a manifold of larger cross-sectional area, conditions favorable to pipeline surge are introduced. The objective must be, therefore, to establish as short a leadout line from pump to manifold as possible, with the least amount of diameter difference between them. Abrupt changes in the size of piping farther along the line should be avoided. Tapered fittings, and the use of short lengths of in-between size pipe may help some.

Where several pumps are in parallel



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operation at a pipeline station, each possibly running at a different speed, the problem of accurate surge analysis is magnified. Most piping systems are so complex that it is impossible to avoid resonant amplification of some of the many impulse frequencies generated by irregular flow. Furthermore, the full effects of the oscillations do not always arise immediately after starting operations, or at any predictable instant thereafter.

Sometimes the pumping may be smooth for hours, until just the right pump speed combines with the right phase and frequency to start the disturbance. Once begun, the surges may persist for a while thereafter, even though speed variations may have changed the phase relationships. Thus the only practical solution is to install effective pulsation dampening equipment on each pump.

Dollars saved, profits made . . . Presumably the complex nature of resonant surge and vibration is reason enough for concentrating remedial effort on dampening the pulsations from which surge problems originate. The tremendous damage which surge can and does cause renders it a matter of unavoidable importance as related to the balance sheet. How does surge control or the lack of it reflect on the balance sheet in pipeline operation? The economic advantages of surge control are:

1. A 57 per cent or greater increase in the operating speed of reciprocating pumps and a similar increase in the discharge capacity per pump.

2. Applying the advantages of permissible speed increase to the present cost of an average 12-in. duplex power pump reduces the initial unit pump cost from $19.70 to $12.50 per barrel per hour of pump capacity.

3. Two 12-in. duplex power pumps (85 s.p.m.) will now have more effective discharge capacity than three similar pumps under previous methods of operation (54 s.p.m.). Consequently, a capital investment of $14,000 will suffice where $21,000 was formerly believed necessary; viz., a 33⅓ per cent reduction in capital investments, depreciation and taxes can be effected without sacrificing pump capacity, as related to previous methods.

4. A reduction in building floor space requirements of approximately 33 per cent where pumps are to be enclosed.

5. A similar reduction in the cost of welding fittings, valves, etc.

6. A material reduction in over-all installation cost, both labor and materials.

7. Reduction in number of pump units to be maintained.

8. A dollar invested in surge control equipment releases 7 dollars in pump capacity, formerly not utilized.

9. Supplements insurance and tends to reduce its cost by minimizing hazards to life and property from which insurance claims arise.

10. Serves to preserve mechanical and other physical assets subject to frequent expensive repairs, when subjected to surge conditions.

11. Serves to preserve pipelines and thereby reduce oil losses (due to ruptured lines) and the resultant right-of-way and damage claims.

Management and engineering personnel must understand that all economic laws are controlled by natural laws and both must understand and collaborate wholeheartedly if maximum returns on pumping equipment investments are to be realized.

It is well to remember that this collaboration must begin before selection and installation of the equipment. An error in equipment selection may have an adverse effect on profits and ownership throughout its entire service life. Such errors are not easily corrected as regards capital assets.

Acknowledgment

The author wishes to express thanks to Dan Hack, of Mid-Continent Pipe Line Co., for his help in gathering and assembling material for this article.

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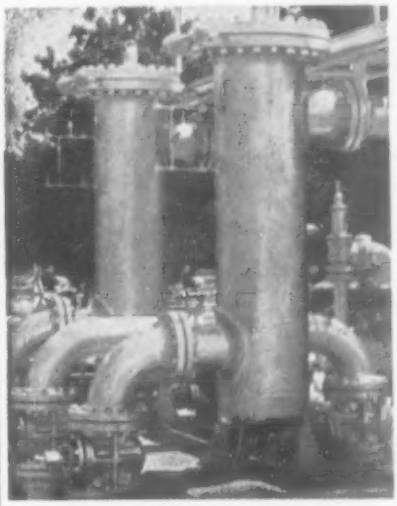

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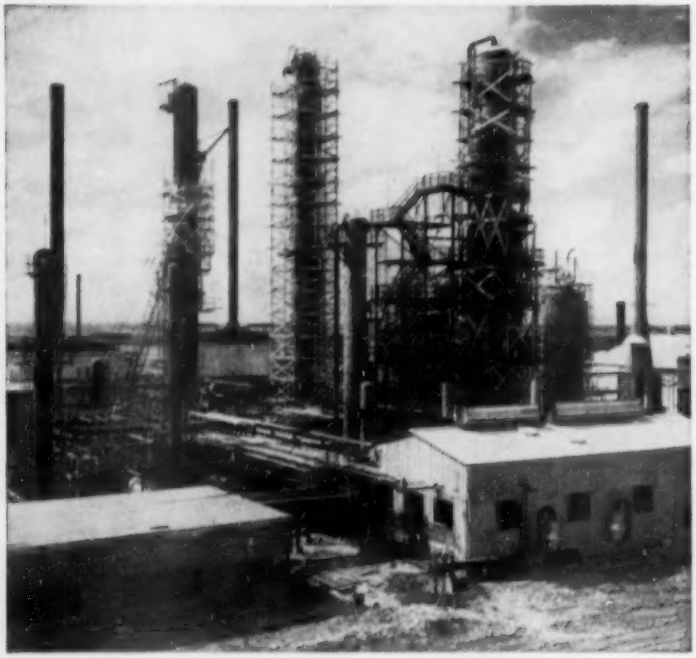

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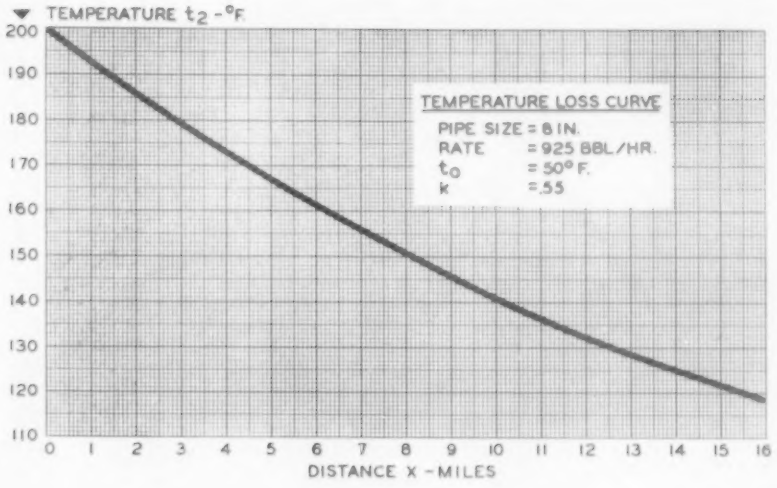
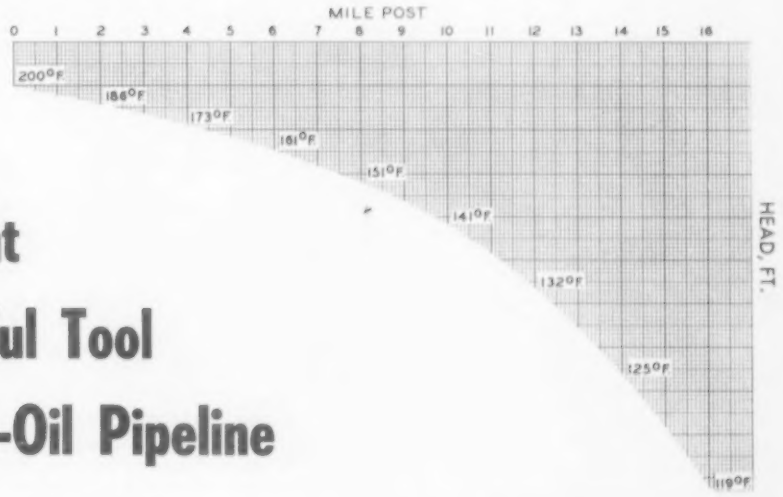


TEMPERATURE LOSS CURVE of oil flowing in a pipeline as calculated by the equation given in this article, using 10° F. temperature intervals. Fig. 1.



HYDRAULIC-GRADIENT TEMPLATE formed by calculating cumulative head loss and plotting from top down. Fig. 2.

Hydraulic-Gradient Template Is Useful Tool In Designing Hot-Oil Pipeline

by H. W. Witter
General Petroleum Corp., Pipeline Department

THE economical pipeline transportation of heavy crudes and residuum fuels requires that these fluids be heated prior to discharge into a pipeline system. The heat added serves to reduce the viscosity of the oil and thereby reduces the friction pressure loss due to fluid flow. This allows the commodities to be transported a greater distance without repumping, but it also complicates the design of such a system.

The oils that require heat for pumping, by their very nature, are those in which the viscosity changes markedly with a change in temperature. As the heated oil flows through the pipeline, heat is lost to the earth and surrounding atmosphere, and the viscosity of the flowing stream increases. The hydraulic gradient then, in contrast to the conventional cold-oil problem, is not a straight line, but is curved because of the change in viscosity and specific gravity with respect to distance traveled. The use of hydraulic gradient templates greatly simplifies the design of such a hot-oil pipeline system.

The writer was introduced to this method of solution by Bechtel Corp. during the initial design of General Petroleum's San Ardo Pipe Line System. This procedure has been used extensively since that time, and the San Ardo system now transports heavy crude having a viscosity of 400 S.s.F. at 122° F. Three combination heating and pumping stations are required in the 40-mile run, and rates in excess of 33,000 bbl. per day are delivered through a combination of 8 and 10-in. line.

Step No. 1 . . . The first step in the design of a hot-oil pipeline system is to choose ground temperatures and heat-transfer coefficients that will best describe the heat-absorption qualities of the environment in which the pipeline will exist. These empirical factors are usually chosen on the basis of actual experience under similar conditions, but in an unknown area an educated guess must be made. Factors to be considered are mean ambient temperatures, rainfall, and type of soil. In California, a winter ground temperature of $t_0 = 50°$ F. and a heat-transfer coefficient of K = 0.70 will usually give conservative results for design purposes.

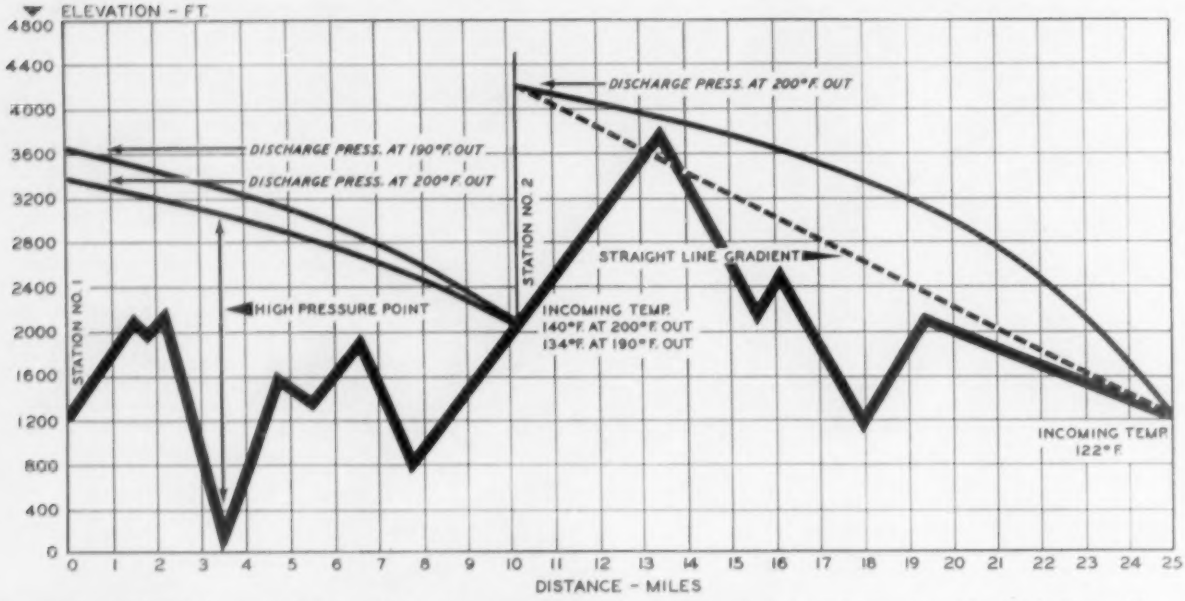
An excellent formula to determine this heat loss was developed by F. L. Maker for an extension course at University of California, Berkeley. This formula reads:

$$x = \frac{2.303}{a} \log \left(\frac{t_1 - t_0}{t_2 - t_0} \right)$$

Where

$$a = \frac{2\pi K}{2.303\, M c_p \log \left(\frac{2D - R}{R} \right)}$$

c_p = specific heat of fluid, B.t.u./lb./°F.
D = depth to center line of pipe, ft.
K = thermal conductivity of ground, B.t.u./hr./sq. ft./°F.
M = mass flow, lb./hr.
R = radius of pipe, ft. (o.d.)



PIPELINE PROFILE showing hydraulic gradient. Note how hot-oil gradient clears peak at the 13.5-mile point while straight line would not. Fig. 3.

t_1 = initial fluid, temperature, °F.
t_2 = final temperature at distance x, °F.
t_a = ground temperature, °F.
x = distance along pipe, ft.

Step No. 2 . . . The second step in the design is to solve the above formula for

$$x = (\text{constant}) \log \left(\frac{t_1 - t_a}{t_2 - t_a} \right)$$

(This constant may be adjusted so that x will read in miles, which is usually more convenient than feet.)

At this point in the design a decision must be made which will determine the maximum allowable temperature to which the oil stream will be heated. Some pipeline operators use maximum temperatures of 140°-150° F. to limit the temperature difference between the oil stream and ground, and thereby limit the rate of heat loss. In pipeline operations at General Petroleum, however, we heat our oil stream to 200°-205° F. if necessary, and higher temperatures have been considered when pumping very viscous oils. We contend that even though the rate of heat loss is higher at the higher temperatures, the reduction in the number of heating and pumping stations required will more than offset the increased rate of heat loss. Sometimes local ordinances limit the maximum temperature at which a pipeline may operate, and all such factors must be considered.

Step No. 3 . . . Once the initial design temperature is determined this becomes t_1 in our formula. The next step is to solve for values of x for various values of t_2 starting with $t_2 = t_1$, at which point x = 0, and continuing downward at 10° F. intervals. From these values a temperature vs. distance curve, such as shown in Fig. 1, may be drawn.

For any one rate, the pressure loss per unit length due to fluid flow is a function of the size of the pipe, viscosity, and specific gravity of the oil. The size of pipe will remain constant, but the viscosity and specific gravity will change because of the loss of temperature as the oil flows through the line. For design purposes, the line under study should be divided into 2-mile intervals. Since the temperature vs. distance curve is a logarithmic curve, the midpoint of each 2-mile interval is the log mean temperature of the section.

This mean temperature is then used to determine the average viscosity and specific gravity in each section. Using this average viscosity and specific gravity, the pressure loss for each 2-mile section is then calculated. Any consistent method of pressure-loss calculation that gives good results may be used. Experience has shown that very little error will be introduced by using average figures for viscosity and specific gravity over a 2-mile interval.

The pressure loss in each 2-mile section should then be converted to feet of liquid head using the average specific gravity for the section. If the process of using a different specific gravity becomes somewhat laborious, an average specific gravity may be used to cover an entire section between two stations, the error introduced being negligible in most cases.

Profile map made . . . In the initial planning stages of a pipeline system a profile map of the pipeline route is usually prepared. Using coordinate paper having the same distance scale as that which was used for the profile map, the accumulated total of pressure loss in feet of head for each successive 2-mile interval is plotted. Pressure loss is plotted to the same scale as elevation on the profile and is plotted from the top down. The plotted points are joined with a smooth curve (a number 60 ship's curve is handy for this purpose) and the curve is cut out to form the template. This is the hydraulic gradient template and is illustrated in Fig. 2. The temperatures as shown on the gradient are selected from the temperature vs. distance curve as calculated above.

With the completed template and pro-

THE AUTHORS

H. W. Witter is an engineer in the pipeline department of General Petroleum Corp. He attended Stanford University and California Institute of Technology. He received his B.S. degree from Stanford in 1943, and after 3 years of military service received his M.S. degree from Stanford in 1947. He has been with General Petroleum since 1948.

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file map it is now possible to proceed with the design and station spacing much in the same manner as in the conventional cold-oil problem with a straight-line gradient. The template may be positioned with reference to the profile so that stations are located at optimum intervals with equalized pumping pressures. The temperatures shown on the template will also indicate the incoming temperature at each station and this will determine the heat load and exchanger equipment required.

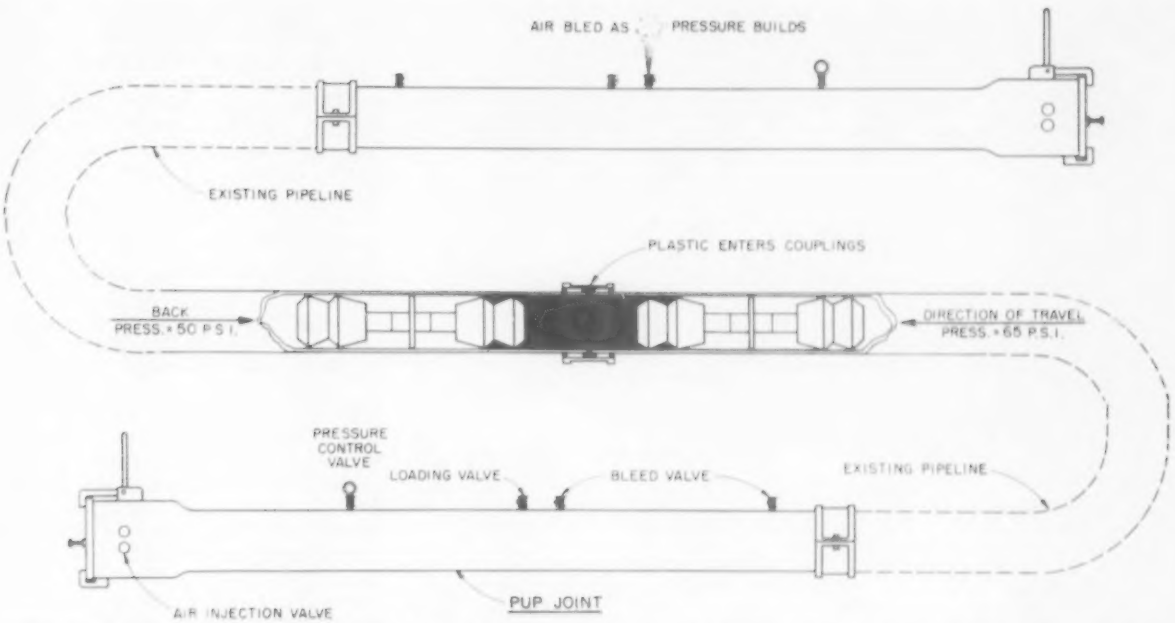
The template may also be used to determine the pressure requirements if the oil stream is pumped at some lower temperature as well as the effect of this lower discharge temperature on the incoming temperature at the next downstream station. This may be accomplished by adjusting the template so that the desired temperature (which will be coincident with some mile post greater than 0) is in line vertically with the station location as shown on the profile.

Avoiding overpressure . . . Another important factor in regard to the design of a hot oil pipeline system is illustrated in Fig. 3. It may be seen that when a hot-oil line traverses a mountainous country it is imperative that the curved shape of the hydraulic gradient be accurately pictured; not only to verify that full flow will be maintained over the high points, but also that overpressure will not be experienced in the deep valleys.

Templates may be constructed using as a base, factors of ground temperature and heat-transfer coefficients to cover other seasons of the year. If the design template is made using wintertime factors, the pipeline system should be more than adequate during the remainder of the year if all stations are in operation.

During summer operations it may be possible to shut down some intermediate pump stations without exceeding the design pressure at the initial station, and some operators may desire to do this. If this is anticipated, a summertime template would be desirable to indicate any possible overpressure points in the line, particularly those points immediately upstream of shutdown pump stations.

In any system, other than one in which the oil stream is used to condense exhaust steam, the most economical mode of operation is effected when only enough heat is added to maintain the operating pressure slightly below maximum throughout all seasons of the year.



OPERATIONAL STEPS in "squeezing" coating. Dotted line represents company line in place. Pup joints are coupled to either end. Fig. 1.

Squeeze Job Reduces Gas Line Leaks

By internally coating in place an old bolted-coupler line Oklahoma Natural reduced leakage 93 per cent. The method shows promise for use in similar lines and may be a way to get complete seals on low-pressure lines.

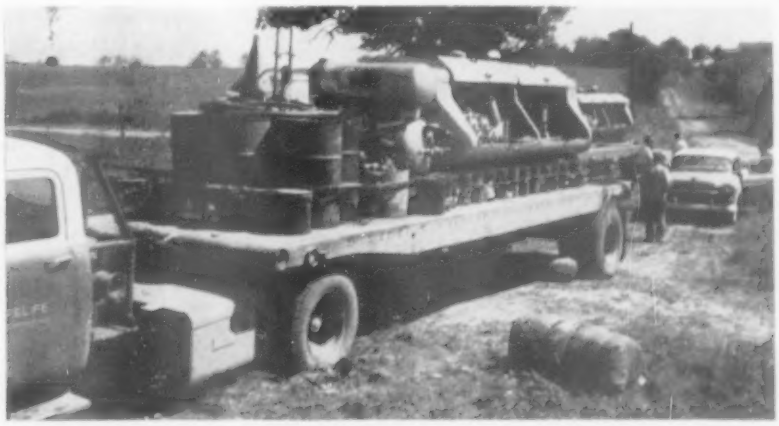
by John Cummings
Oklahoma Natural Gas Co.

OKLAHOMA NATURAL GAS CO. recently reduced leakage in a 2-mile section of an old coupled line near Beggs, Okla., over 93 per cent with an internal "squeeze" job.

An epoxy-resin type of coating was squeezed into the couplings in one of the first such in-place applications on a coupled line as large as 8-in.

Before coating, the line was tested through parallel positive-displacement meters at 100 psi., (normal operating pressure is 75 psi.), for a period of 24 hours. Leakage amounted to 292,000 cu. ft. daily. After coating, the same test was applied with leakage of 19,100 cu. ft. daily recorded.

Work was performed by Pipecote Service Corp., of Tulsa, using the Pipelife process of Pipelife Corp., San Angelo, Tex. Contract cost of the job was 49 cents per foot.

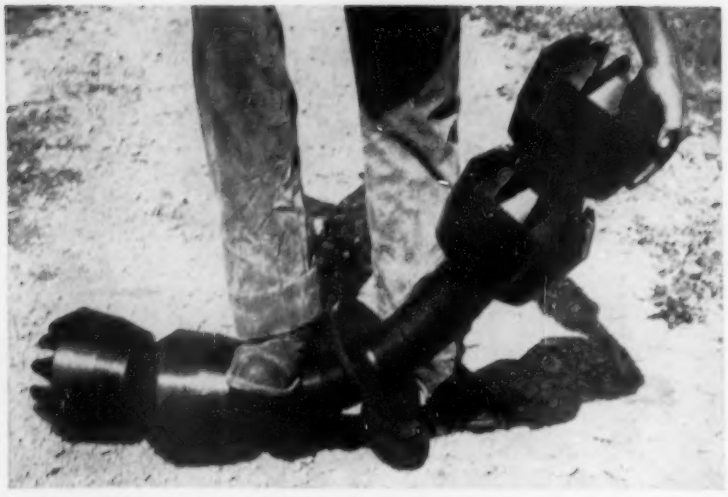


TRAILER-MOUNTED air compressors rated for 500 cu. ft. of air at 100 psi. are stationed at each end of line to provide pressure for coating. Fig. 2.

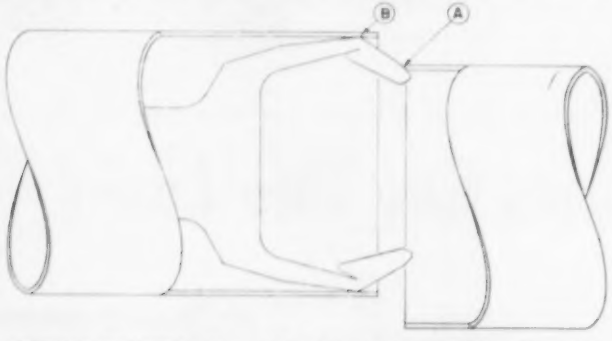
History and Condition of Line

Laid around 1919, the line serves Beggs from a point in the Oklahoma Natural system near Okmulgee and runs across extremely rugged hill country. Total length is about 11 miles. The section selected was chosen because only one main-line customer would be inconvenienced. Another factor was remoteness, which allowed cleaning and blowing operations to take place without disturbing outside persons.

Leakage in the coupling rubbers had resulted in large transmission-line loss relative to the amount of gas being used in the Beggs city distribution plant. It was decided to test-coat an 11,000-ft. section to determine if leakage could be reduced. Factors which presented a challenge to internal in-place coating included: (1) age of the line, with resultant accumulation of dirt and scale, (2) lack of information as to uniform-



FLEXIBLE NEOPRENE PLUG designed for smooth passage through coupled lines. Fig. 3.



GUIDING FINGERS of new plug help entry into offset joint. Also, pressure at "A" is transmitted to "B," holding contacting edge against pipe wall. Fig. 4.

DOUBLE-OPPOSED PLUG used in normal internal wall coating was unsuitable for coupled line due to rigidity and tendency of forward bells to catch on joint edges. Fig. 5.

ity of diameter, (3) line contour with its highs and lows, and (4) offsets between joints inherent in coupled lines.

Principle of Operation

Pup joints, shown in Fig 1, are coupled to each end of the line to be coated and air compressors are tied into the air-injection valves. The section is first cleaned thoroughly (described in detail later). To load for coating, a forward plug assembly is inserted in the pup joint. The quick-opening end port is snapped shut and a shot of air introduced behind the plug to move it a short distance down the line.

The port is then opened and the rear plug assembly inserted. After closing the port, liquid coating material is pumped in between the plugs. Air pressure is applied at the opposite end of the line, returning the lead plug toward the end port in the pup joint and compressing the coating material between the two assemblies.

Pressure is then applied behind the driving plug in a sufficient amount to overcome the back pressure, which is held constant by watching a gage at the opposite end and bleeding sufficient air to maintain the desired pressure.

The "train" of plugs and coating moves down the line at a controlled velocity, compressing the plastic between the joints into the Dresser couplings and filling the voids. The plastic is then dried with air until it hardens.

Actual Cleaning and Coating Operation

Cleaning . . . Following is a log of steps taken in cleaning and coating the line:

1. Line pressured with air and blown twice, at 50 and 80 psi., respectively, to remove dust and loose materials.

2. Line loaded at south end with two balls of waste rags, followed by two balls of steel cuttings (such as found in machine shops) and two more balls of waste. This load lodged on the seating ring of a gate valve, resisting a pressure of 100 psi. A gate valve near each end and one in the middle were then removed and spools installed to give unrestricted diameter for the operation. It had been originally planned to leave the valves in place to determine what effect the coating would have on them.

3. A load of two balls of waste, three balls of cuttings, and two balls of waste was then run through the line to pick up moisture and clean the walls. This was repeated seven times.

4. Line was pressured to 50 psi. and blown down.

5. A pig, 18 in. long, consisting of three bells and two disks, was run, passing through in good shape.

6. Line again pressured to 50 psi. and blown down.

7. Three barrels of methyl ethyl ketone were poured into south end and chased with swabbing plug. The M.E.K. acts to clean the pipe walls and prepare the surface for coating. Swabbing plug was then rerun.

8. North end of line was opened and compressor on south end blew air stream through for about 4 hours to dry the M.E.K.

Coating:

9. Line was loaded for coating with 25 gal. of plastic (see Table 1) ahead of the first plug assembly to lubricate and 270 gal. between the plugs. Travel time for the train through the line was 30 minutes. Driving pressure was 35 psi. and back pressure 5 psi. After passage through the line, 215 gal. of coating was recovered, leaving 80 gal. in the line. The line was then left over night with 5-psi. air pressure on it.

10. The next morning the line was loaded from the opposite or north end with 25 gal. ahead of the first plug and 175 gal. between the plugs. Driving pressure was 45 psi. and back pressure

TABLE I—PHYSICAL PROPERTIES OF COATING

Curing time using Pipelife method	6 hr. at 70° F
Breakdown temperature	400° F.
Viscosity	75-85 Krebs Unit
Weight per gallon	11.7-11.8 lb.
Specific gravity	1.41
Pencil hardness	4-H
Sward hardness	33
Impact resistance	160 in.-lb.

15 psi. Travel time was 27 minutes. For this run, the 8¼-in. disks were removed from the plug assemblies, leaving the smaller-diameter (8 in.) bells, and, consequently, the plastic was spread on the walls with none recovered. Total coating in the 11,000 ft. was now 280 gal.

11. Tail plug was run through by itself to help spread the coating and to determine if line was free.

12. Compressor was tied on one end with bleed-off open at the other, sufficiently to put 20 psi. on the line and an air stream was blown through for 11 hours for drying purposes. Upon examination of the plastic near the open ends, it was found to be still relatively soft. The weather during this period was cold and damp. It was decided to leave the section open to the atmosphere for 4 or 5 days before testing.

Results

Tests for a 24-hour period showed leakage to be 96,000 cu. ft. daily or about 13 per cent of that before coating. It was decided to give it another squeeze job in an attempt to reduce leakage still further. In addition, a pig was run and became stuck near the middle of the line. When taking up the section to remove the pig, it was found that the coating had accumulated in the low spots to a depth of about 4 in.

Recoating With New Plug

Before reentering the line, Pipecote designed a new type of neoprene plug,

THE AUTHOR

John Cummings, Jr., district engineer with Oklahoma Natural Gas Co., Tulsa, has had varied experience in the operating department of Oklahoma Natural for the past 3 years. Previously he was in the production department for Stanolind Oil & Gas Co. for 1½ years and prior to that 3 years with The Oil and Gas Journal. He received a B.S. degree in mechanical engineering from University of Oklahoma in 1946, and an M.A. degree in technical journalism from Oklahoma A. & M. College in 1949.

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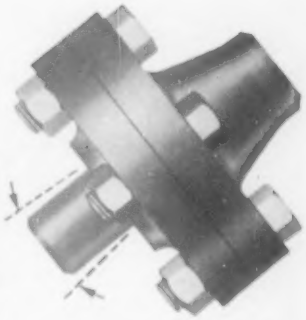

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shown in Fig. 3. It has great flexibility and was designed specifically for coupled lines where offsets might be encountered. It provides for holding a seal on the plastic column while coating and at the same time special guiding fingers allow passage through a reduced diameter or offsets between joints. This ability is shown in Fig. 4. Another feature of the plug is that any pressure on the tip "A" will be transmitted to the heel and drive the contacting edge still harder against the pipe wall at "B."

Operation

With a load of 200 gal., a driving pressure of 65 psi., and a back pressure of 50 psi., rate of travel of the coating and plugs was 106 ft. per minute. Sixty gallons were left in the line and 140 gal. recovered.

A second run was attempted but the plugs parted, dumping 200 gal. of plastic in the line. After digging the line out and recovering the plugs, so much time had been consumed that it was necessary to make three quick runs with wiper plugs to spread the load. Parting of the plug was due to the threaded connections pulling loose from the neoprene body. This bug has since been overcome.

Results

Low points in the line, where coating had previously run down, were inspected and no accumulation was found. Several couplings were dismantled and examined, showing various degrees of plastic fill-up. Some had almost complete fill-up behind the pipe up against the rubbers; others were streaked in this area; and in some cases only a plastic seal was left between ends of adjoining joints. The amount of leakage in any coupling would, of course, determine the back pressure opposing fill-up.

After about a week in which the line was left open, a 24-hour leakage test was made with the results reported previously. Original leakage had been reduced by nearly 94 per cent. With the line pressured up, several couplings were tested with soap and water and some were found to contain small seep leaks.

It is believed that nearly complete leakage reduction might be achieved by using a larger applicating pressure and a greater number of coating runs. It is assumed that each succeeding layer will fill more tiny voids and increased pressure will help drive the coating into these minute leakage spaces where frictional resistance to a viscous coating is considerable.

It is planned to retest the section in a few months to determine durability of the plastic.

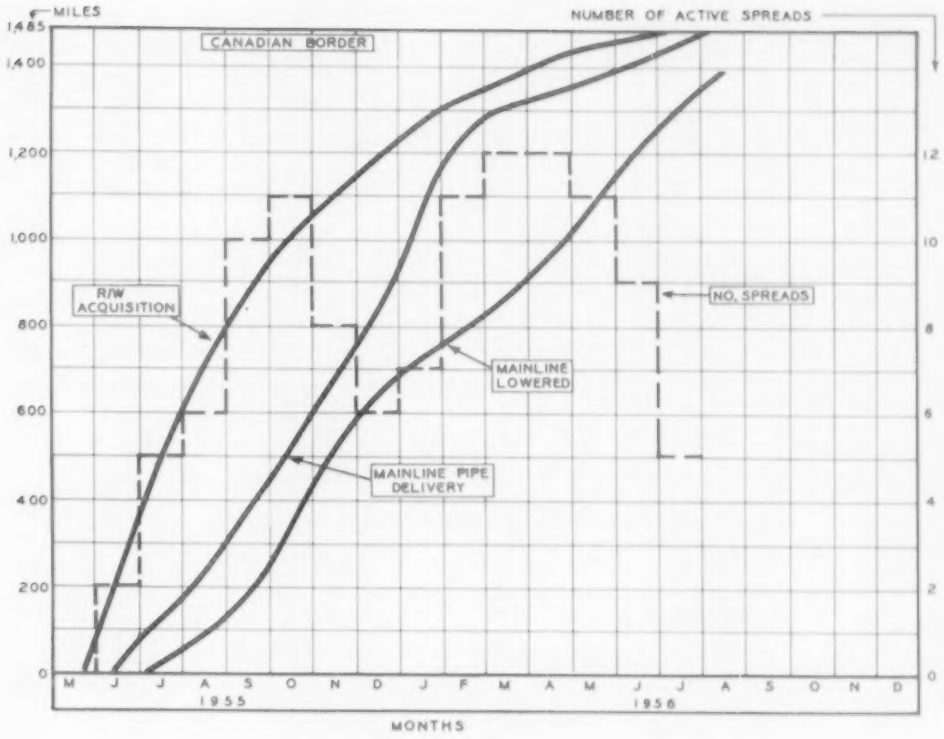


CHART of construction progress on Pacific Northwest's main line. Note how pipe deliveries were spaced to keep spreads working. Fig. 1.

WINTER weather posed big obstacle to pipe laying in late 1955 and early 1956. This ditching machine was in Idaho last winter.

Pacific Northwest line nearly complete, but

"Unusual" Problems Were Commonplace Here

Gas is now flowing through the 1,485-mile Pacific Northwest main line. Many tough engineering and construction problems had to be overcome before this was true. This article recounts major problems and their solutions.

by Paul F. McBride
Fish Northwest Constructors, Inc.

OVER 2,020 miles of the 2,460 total are now complete in the Pacific Northwest pipeline system. The date of final completion of these facilities is only a month away, so a backward look at some of the problems which faced Fish Northwest Constructors, Inc., is in order. In May 1955, with an FPC certificate granted and construction money obtained, there were several problems that, to say the least, were quite real and pressing.

The basic design of the pipeline system itself at its northwestern extremity in the State of Washington was somewhat fluid. After receiving the FPC permit to serve various markets in Washington, another application was filed to permit Pacific Northwest to bring gas from Canada. The first permit required a main line of 26, 22, 18, 14, 8, and 6-in. diameter pipe from the San Juan basin north to a point near Bellingham, Wash. The latter application changed the 18-in. and smaller main line to a single 26-in. line.

The former system had a maximum deliverability of 340 M.M.c.f.d.

The system as now authorized and constructed will have a maximum capacity of 640 M.M.c.f.d. with gas coming in from Canada. This meant that final commitments for pipe, valves, coating, and other materials and installation contracts could not be made or all of the compressor-station designs completed until the new authorization was received.

Coordinating steel deliveries . . . Meanwhile there were 392 miles of 26-in. line and 671 miles of 22-in. line as well as the San Juan gathering system, Piceance Creek, and Big Piney gathering system to be completed from north-

ern New Mexico to the Columbia River in Washington. As can be seen from Fig. 1, it was necessary at the outset of construction to carefully coordinate pipe deliveries in the correct wall thicknesses to keep the various spreads supplied with pipe.

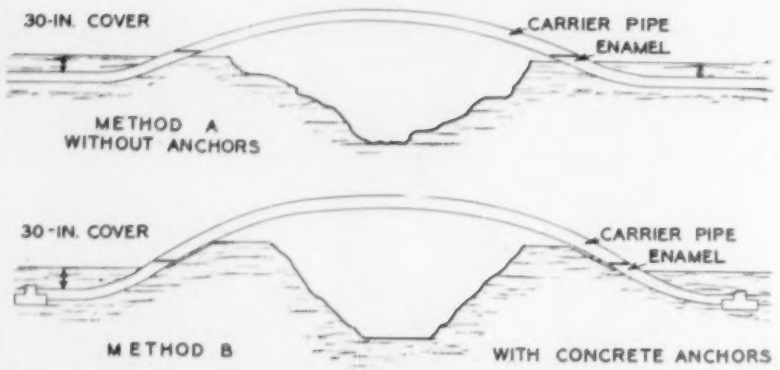
This problem continued throughout the summer and fall of 1955 until winter weather conditions slowed construction progress.

Asphalt coating . . . The selection of pipe-coating material to be used was carefully studied prior to beginning of construction, and after weighing carefully the factors of cost, deliverability, ease of application, and durability, a modified asphalt coating was selected.

Table 1 shows typical specifications used by Fish Northwest under which asphalt coatings were manufactured for the project. Setting forth these specifications to the suppliers did away with many difficulties previously experienced by asphalt-coating users. The coating supply contracts required that manufacturers periodically submit to independent test laboratories samples of their primer and enamel. Tests were made to check for conformity with these specifications listed.

To avoid wasting asphalt coating, pipeline contractors were required to include coating materials in their bids at a unit cost furnished by the company. This unit cost was based on manufacturers' recommended rates of usage and price of material delivered to various warehouses along the line. When work schedules were completed any usage in excess of this amount was deducted from payments to the prime contractor.

Also included in the pipeline contracts, of course, were minimum specifications covering thickness of coating to be applied. By this means undue wastage of coating material was eliminated. Portions of the 26-in. main line now have been in the ground for more than a year, and this coating is still in excellent condition.

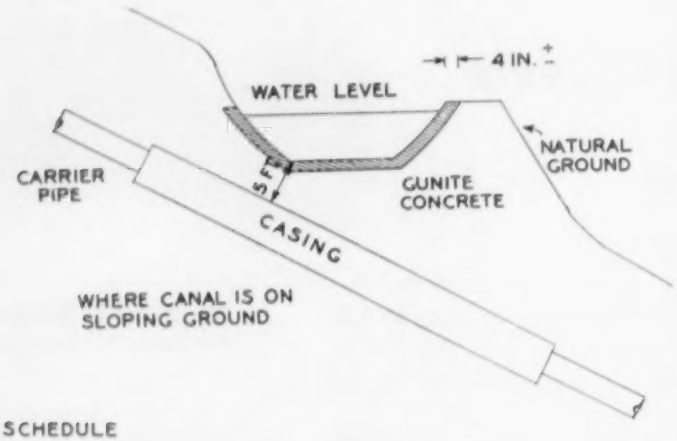


SPANS WERE USED on many canals and sharp ravines and gulleys. Table 2 gives the maximum span lengths. Fig. 3.

Main-line valves . . . Main-line block valves, side valves, and blowoffs are all of the plug-valve type with an A.S.A. 400 rating to go with the 800 psi. maximum working-pressure design of the main-line pipe. Extruded blow-

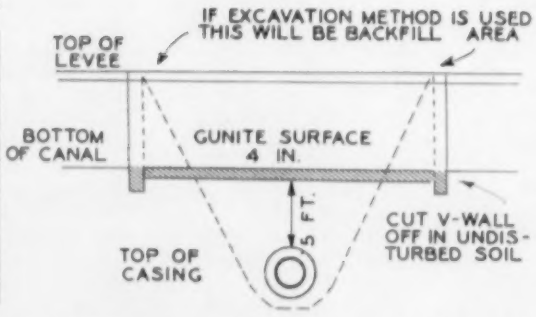
TABLE 1—COATING AND PRIMER SPECIFICATIONS

General Specifications for Modified Asphalt Pipeline Enamels	
Weight, lb. per gal at 60° F. max.	9.75-10.25
Specific gravity	1.18-1.24
Flash point, Cleveland open cup, °F.	525-575
Softening point, ring and ball, °F.	235-250
Penetration at 77° F., 100 gal./5 sec.	4-8
Penetration at 32° F., 200 gal./60 sec.—min.	3
Penetration at 115° F., 50 gal./5 sec.—max.	19
Blunt rod test—2 psi., 6 hours, at 115° F.—max. (in.)	.020
Blunt rod test—2 psi., 100 hours, at 85° F.—max. (in.)	.010
Ash (mineral filler), per cent by weight	19-25
Settlement ratio at 390° F.—24 hours, max.	1.02
High temperature sag test at 160° F., 24 hours	None
Low temperature crack test at −20° F., 6 hours	None
Peel test, 60° F. to 160° F.	None
Break test at 77° F., 1 in. mandrill	None
Water absorption—35 weeks, max. per cent	1.30
Loss on heating—24 hours at 400° F.—max. per cent	0.60
General Specifications for Modified Asphalt Primers	
Bond strength, 77° F., psi. min.	250
Flash point (open tag), °F., min.	100
Viscosity at 77° F. (Stormer cup, 100 g.) sec.	20-35 or
Viscosity at 77° F. S.s.F.	30-45
Softening point (R & B) dry film, °F.	170-190
Needle penetration, dry film, 100 g., 5 sec. 77° F., hundredths CM	8-15
Solids, per cent	30-45
Coverage per gal., sq. ft., min.	400
Drying time at 85° F., 60 per cent rel. humidity approx.	1 hour



CASING SCHEDULE

PIPE SIZE INCH	CASING INCH
4	8
6	10
8	12
10	14
12	16
14	18
16	20
18	22
20	24
22	26
24	28
26	30


IF EXCAVATION METHOD IS USED THIS WILL BE BACKFILL AREA
TOP OF LEVEE
BOTTOM OF CANAL
GUNITE SURFACE 4 IN.
5 FT.
CUT V-WALL OFF IN UNDISTURBED SOIL
TOP OF CASING

TYPICAL CASED CANAL CROSSING showing steep angle which some boring jobs required. Fig. 2.

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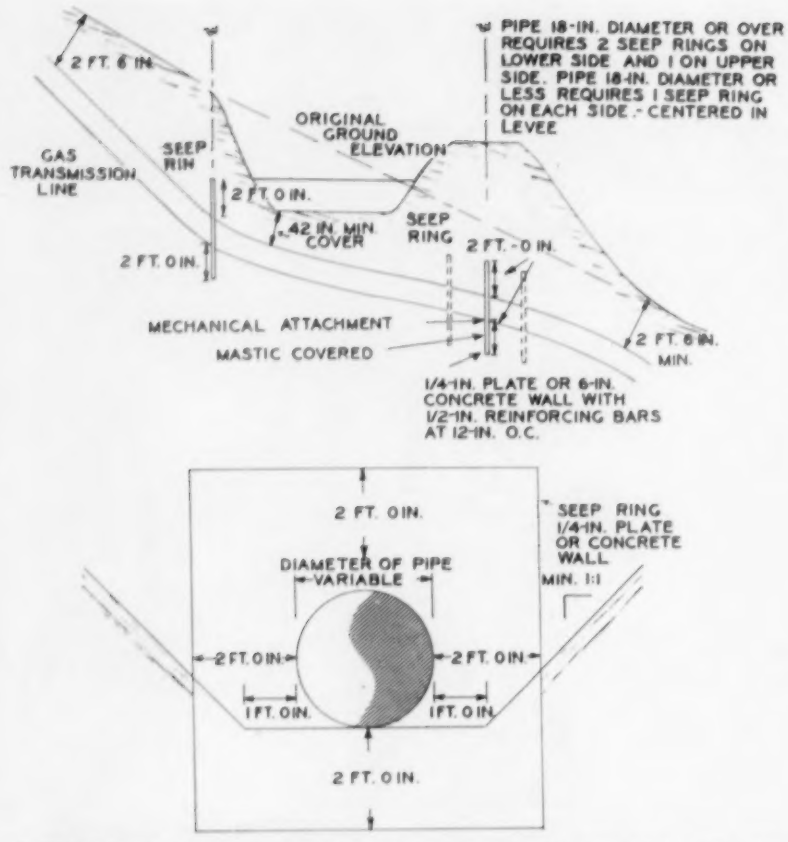
2 FT. 6 IN.
PIPE 18-IN. DIAMETER OR OVER REQUIRES 2 SEEP RINGS ON LOWER SIDE AND 1 ON UPPER SIDE. PIPE 18-IN. DIAMETER OR LESS REQUIRES 1 SEEP RING ON EACH SIDE - CENTERED IN LEVEE
ORIGINAL GROUND ELEVATION
GAS TRANSMISSION LINE
SEEP RIN
2 FT. 0 IN.
42 IN. MIN. COVER
SEEP RING
2 FT. 0 IN.
2 FT. 0 IN.
MECHANICAL ATTACHMENT
MASTIC COVERED
2 FT. 6 IN. MIN.
1/4-IN. PLATE OR 6-IN. CONCRETE WALL WITH 1/2-IN. REINFORCING BARS AT 12-IN. O.C.
2 FT. 0 IN.
SEEP RING 1/4-IN. PLATE OR CONCRETE WALL
DIAMETER OF PIPE - VARIABLE
MIN. 1:1
2 FT. 0 IN.
2 FT. 0 IN.
1 FT. 0 IN.
1 FT. 0 IN.
2 FT. 0 IN.

SEEP RINGS of steel plate were welded to pipe to prevent water from canal seeping along pipeline trench. Fig. 4.

off fittings were shop welded to either end of all block valves in sizes 16 in. and larger before delivery to the field. All blowoffs are 8 in. diameter for both the 26 and 22-in. main line.

Each main-line block valve has been further provided with a quick-opening cap and permanent bypass. The design of these installations, plus all other portions of the transmission line, has been in accordance with a standard at least equal to or better than the A.S.A. 1955 Code for Gas Transmission Piping Systems. No automatic valve operators on the main line have been provided.

Line Construction Obstacles

The route of the 26-in. line through western Colorado required the line traverse Douglas Pass—elevation 8,630 ft. The approach to this pass is up an increasingly narrow canyon at the bottom of which our pipeline right-of-way shares the available space with a state road and another gas line.

Although this pass is probably one of the more spectacular obstacles to the pipeline's route, careful location selection allowed the contractor to lay this section of line with no undue incidents. Location of compressor stations on either side of this pass is such that the line rises 2,800 ft. from Station 2, 110 miles to the south, and descends 3,100 ft. to Station 4, 40 miles to the north.

The main line and its major laterals cross nine major rivers at which dual-line crossings were made. Once the line location was selected for approaches to the various crossings, no undue problems were encountered until reaching the Columbia River crossing between Oregon and Washington near Umatilla, Ore.

This crossing is approximately 4,000 ft. wide with a depth in the channel of 20 to 30 ft. ranging up to 6 ft. average near either shore. The bottom consists largely of rock, quite a bit of which was found in the form of "hay stacks" just beneath the surface of the water. Considerable rock drilling and blasting was required for this crossing not only to provide a ditch for the line itself, but also to provide sufficient water depth for the dredge to work.

Over and under canals . . . Minor, but often recurring, obstacles along the pipeline route have been irrigation canals, ranging in width from 3 to 75 ft., rock bluffs, and ravines. The majority of these canals found in Idaho and Washington have been crossed by boring in the same manner as that in which road crossings are normally installed.

TABLE 2—ALLOWABLE SPAN LENGTHS

O.d. in.	W. T. in.	A.P.I. grade	Span length, ft.
26	.281	5LX52	99
26	.344	5LX52	106
26	.406	5LX52	112
26	.500	5LX52	120
22	.250	5LX52	92
22	.312	5LX52	100
22	.344	5LX52	103
22	.500	5LX52	116
20	.250	5LX52	91
20	.281	5LX52	95
20	.312	5LX52	98
20	.500	5LX52	113
18	.281	5LX52	93
18	.500	5LX52	110
16	.250	5LX52	88
16	.500	5LX52	107
12¾	.250	5LX42	71
12¾	.500	5LX42	85
10¾	.250	5LX42	69
8⅝	.188	5LX42	61
6⅝	.188	5LX42	58
6⅝	.219	5LGr.B.	50
4½	.188	5LGr.B.	40

To prevent leakage of water through the bottom of these canals into the pipeline ditch out along the right-of-way, seep rings consisting of 6 by 8-ft. steel plates were welded to the line. Following this, backfill was puddled with water or tamped to provide as much resistance as possible to any leakage which might occur. Rock bluffs and cliffs were crossed by shooting out rock from the top of the cliff and providing a false right-of-way at the bottom into which the line was laid.

Sharp, narrow ravines where they could not be avoided have been spanned. All spans have been installed

THE AUTHOR

Paul F. McBride is presently assistant superintendent of construction for Fish Northwest Constructors, Inc., engineers and supervisors of building the Pacific Northwest pipeline system. He holds a B.S. degree in mechanical engineering from Texas A. & M., graduating in 1948. Previously he was with United Gas Pipeline Co. for 3 years in the construction engineering department; with Coates Field Service, Inc., as chief engineer; and with Algonquin Gas Transmission Co. as an engineer for 3 years. He joined the Fish organization in May 1955 as assistant chief engineer of Fish Northwest Constructors. During service with these organizations he has continuously been engaged in design, construction, or operation of natural-gas compressor stations, pipelines, and related facilities.

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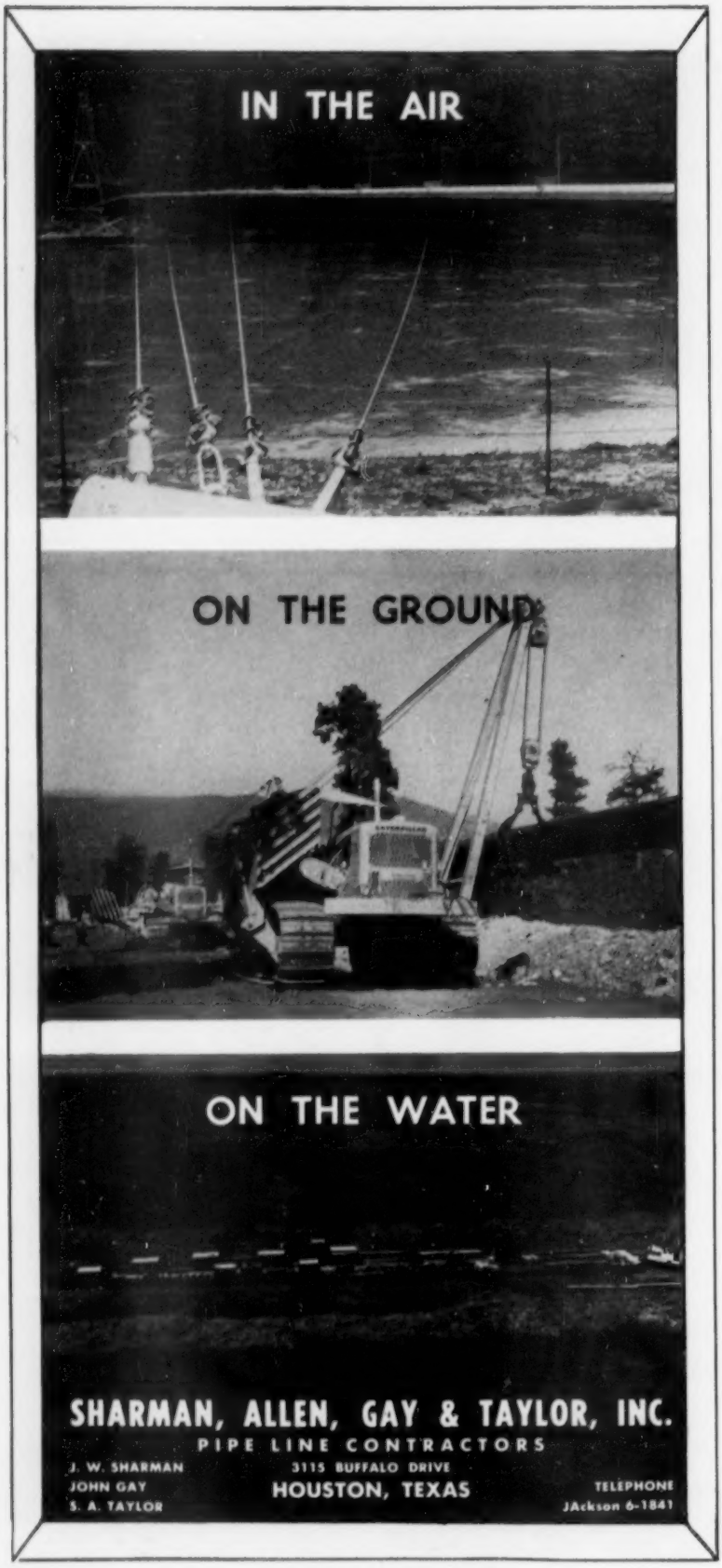


by the main-line contractor in the field and in most cases consist of a sag bend well back into the bank at either side with a slight overbend in the middle of the span. Table 2 shows recommended span lengths for various pipe diameters and wall thicknesses furnished by Fish Northwest's engineering department.

Line Testing

Testing operations have employed gas, air, and water as test media. Since the main line has been completed in several areas simultaneously away from available sources of gas, it was necessary to employ a hydrostatic-testing contractor to proof test a large portion of the main line.

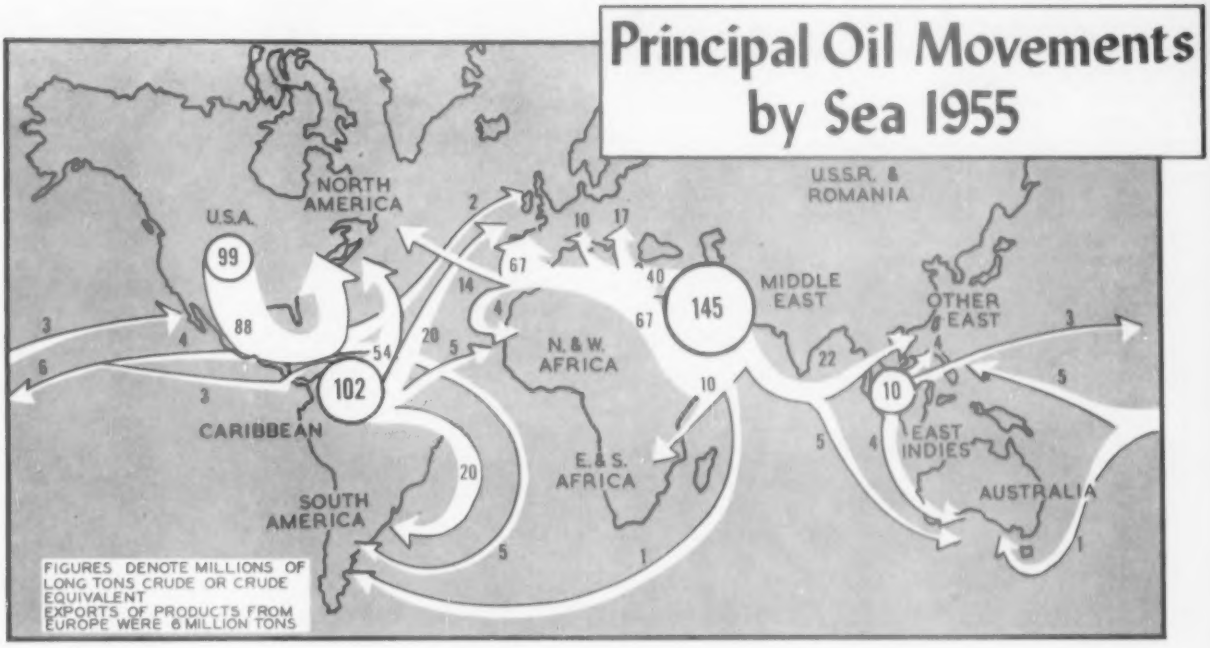
To date 503 miles of main line pipe have been gas-proof tested, and 572 miles have been hydrostatically tested. Due to steepness of terrain in the area of hydrostatic test, it was necessary to break the pipeline into test sections so that the hydrostatic head would not exceed the pipe's yield point.

It was felt that attempting to carry each test section to a point in excess of the yield would do little to improve the strength of the line since within each test section there were so many high points. Manifolds were spaced elevationwise to provide the maximum test pressure on the high points in accordance with the A.S.A. code. They were spaced within a given test section and a maximum test pressure at low points approximately halfway between mill test pressure and the theoretical minimum yield pressure. This rule of thumb method works very well.

Pipe strung by aerial cable . . . The route of the 26-in. main line in southern Washington as it follows the Columbia River gorge on its way to the Portland-Seattle markets has crossed terrain features extremely unusual to the pipeline industry. Several canyons and mountains have been crossed with sides so steep men could not walk up or down the slope. Also, in the bottom of these canyons there is little working space between walls.

Across one such canyon a cable trolley was rigged so pipe joints could be strung and lowered into place from the trolley. At the very bottom the canyon is so narrow that a span had to be designed. Within this same area, because of extreme changes in elevation of these canyons, ranging from 1,500 to 2,300 ft., air was used as the testing medium.

This article presents a few of the troubles Fish Northwest had on this project as far as the pipeline is concerned. Gas is now in the main line to Washington, and five sales-meter stations have been activated.



Special Journal report

PIPELINES OR TANKERS . . .

which will move Middle East oil?

The Suez fracas has stirred up some interest on new pipelines that would bypass the canal. Here's a discussion of the possibilities, with the conclusion that supertankers now being designed, plus delicate political factors, make additional pipelines doubtful.

BY 1975 it is probable that oil production in the Middle East countries destined for points west of the Suez may amount to 5,000,000 bbl. per day. The problem is mainly one of moving the oil from this producing area to major consuming centers. The crucial question is whether this oil can best be moved by tankers or pipelines, or a combination of both. The answer involves several factors.

The future costs of moving oil from Persian Gulf ports to locations west of Suez will be conditioned by the costs of operating a fleet of large, efficient, and economical tankers, furnishing low-cost transportation in competition with pipelines. Such a condition is healthy for the producers, consumers, and all concerned. It assures that the most economical form of transportation will be developed to deal with the increased volume of crude oil that will have to be moved to market.

At present, a pipeline has a slight cost advantage over tankers transporting oil from the Persian Gulf to the Mediterranean. And giant tankers now being built will undoubtedly wipe out this advantage because of their lower operating cost. In the immediate future therefore, the pipelines already in operation between these points will be hard-pressed to keep expenses low enough to meet this challenge. New pipelines will be economically justified only under the most favorable conditions, viz., low construction costs, efficient management, continuously high throughput, and the sincere cooperation of the countries through which they pass.

Favorable Political Climate Essential

A tanker has the all-important advantage of flexibility. Thus if one route is found unprofitable, or if there is any interference with its normal operation, it can easily be shifted to another more profitable route. A pipeline, on the other hand, is a fixed facility. Therefore the requisite low pipeline operating costs and security of operations can be attained only if the following basic conditions are met:

1. There must be a consistent demand for a large quantity of additional crude oil in the consuming areas (Western Europe and the United States) so that the line can be operated at full capacity.

2. The lines must be designed at the highest efficiency and lowest operating costs, which means large-diameter lines (30-36-in. or more) with a minimum number of pumping stations equipped with simple and robust machinery.

3. They must be built at a minimum cost, which entails skilled planning, scheduling, and the highest degree of aptitude in the employment of power, construction equipment, and techniques.

4. The Middle East governments concerned must, above all, provide a stable, favorable economic climate to justify huge investments needed by new pipeline facilities. Any corporation making such an investment should have

assurance that the state concerned would provide continuously, for the period of the concession: (a) security for title to property or rights conceded, and reliability of contracts entered into; (b) noninterference with managerial control of the company's normal operations; (c) the opportunity to make a fair profit on the capital investment. Without these guarantees no responsible concern can afford to risk large sums required from its shareholders for such a project.

In favorable economic conditions, designers, builders, and operators will shoulder their respective responsibilities and normal business risks. Under these conditions alone, pipelines in the Middle East will prove a sound investment, conferring benefits on the inhabitants of the territories concerned and consumers of oil and products at large.

Economics of Pipeline and Tanker Transportation

The unilateral action by the Egyptian Government under Colonel Nasser of nationalizing the Suez Canal Co. on the one hand, and Lebanon's threat to Iraq Petroleum Co.'s pipeline passing through its territory, in an effort to extract more revenue from this international concern, on the other hand, focus attention on the transportation of Middle East oil by tankers and pipelines, and its economics and politics.

For the movement of oil over long distances marine transportation is generally found cheaper for the same mileage than by pipeline. Thus the Trans-Arabian pipeline across Arabia, from the Saudi Arabian oil fields to Sidon, a distance of 1,000 miles, reduces the westward tanker haul by 3,700 miles. Moreover, tankers using the Suez Canal have to pay transit dues equivalent to the cost of a further 1,000 miles of sea voyage. Hence the cost advantage for the pipeline under such circumstances is considerable.

But this cost position is in a state of flux, because the size of the ocean-going tanker has gone up considerably since the second World War. The outlay for transportation of oil in tankers of 12,000 d.w.t. was stated in 1953 to be roughly one-quarter higher than in vessels of 32,000 tons. Larger tankers are now in operation which will still further reduce costs, though the largest vessels (100,000 or even 80,000 tons) will not be able to dock at any European oil ports, until the ports have been suitably modified. Also the vessels cannot use the Suez Canal route.

Pipeline cost double tankers . . . Estimates published by the Institute of Petroleum (London) in 1954 indicated that if a large-diameter pipeline (30-in. and over) were utilized to its full capacity, its costs per ton-mile would be double those of a 32,000-ton tanker. Smaller-diameter pipelines, or those utilized under full capacity, would have appreciably higher costs.

Reasons for this are set out partly in terms of steel and power requirements—the steel requirements for moving the same quantity of oil the same distance being over twice as high, and power needs virtually double, in a 30-in. pipeline as in a 32,000-ton tanker. The full comparison would, however, be highly complex, and cannot be computed precisely at the present time. Tankers, for example, would almost certainly suffer more corrosion than pipelines, and, hence, probably call for more maintenance. Also, the cost of power varies in different localities. Providing pumping stations is costly in the Middle East where community centers must be built.

Well over half the oil and petroleum products consumed in Western Europe is imported via the Suez Canal. For Britain alone the figure is as high as 75 per cent. Even the United States has a direct interest, since by this route come some 15 per cent of its oil imports.

The distance from the Persian Gulf to the U.K. is greater by two-thirds through the Cape of Good Hope than

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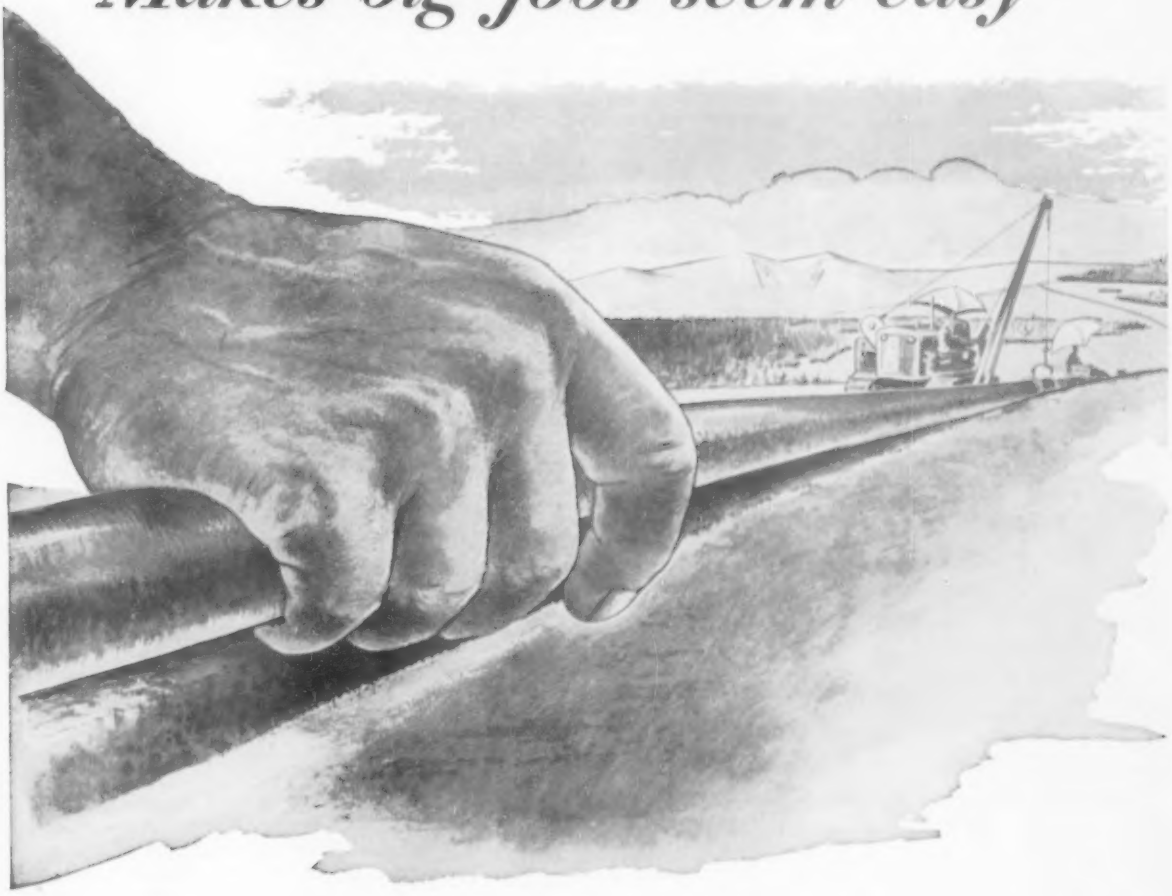

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the canal; to the East Coast of the United States it is 42 per cent longer. Shipping costs are raised by a smaller proportion than the increase in distance, but it is evident that the cost of oil imports, by tankers designed for the Suez route, would be significantly increased if the detour round the cape had to be made.

If canal closes? . . . It is more than likely that the Suez Canal route will remain open, that transit dues will not be raised, and that the canal will continue to be operated efficiently. Nevertheless, it is common sense to consider what developments would be likely to follow if the canal became unusable for either economic, or political reasons. Two developments in particular appear feasible.

Firstly, there might be a general re-routing of oil supplies throughout the world, as was necessary when the (Persian) Abadan refinery was shut down, with the object of reducing the use of the canal to the minimum. Since oil resources are geographically well spread out, it would be feasible to alter the current links of producing and importing countries to a large extent, and at a cost which might not be excessive relative to the use of the cape route by the present tanker fleet.

Thus, a larger amount of the Middle East oil output could be sold in Southeast Asia and Australia. Then, the U.K. could import more crude from the Caribbean. Also, the United States could utilize its West Coast ports to a greater extent, and augment its purchases from Indonesia. Lastly, there is the possibility that a larger proportion of the Middle East crude destined for Western Europe and the United States could be brought to Mediterranean ports, overland by pipeline.

Secondly, the future world tanker fleet will, to a large extent, be composed of fast supertankers. According to the Petroleum Press Service, London, "it is already cheaper to route a ton of oil in a supertanker from the Persian Gulf to the United States East Coast via the cape than to send it in a smaller tanker through the Suez Canal." To a large extent, the design of supertankers (40,000 d.w.t. plus) is still in the experimental stage, but they can be expected to become even more efficient relative to the tankers which are able to use the canal.

On a normal day in 1955, 40 ships passed through the Suez Canal, of which 22 were tankers. Of the total Middle East oil production of 3,000,000 bbl. per day or 20.6 per cent of the world output, an average of 1,360,000 bbl. per day passed through the canal, compared with 813,000 bbl. per day via the pipelines. In 1956 it is reckoned that the amount of oil passing through the Suez Canal will average 1,620,000 bbl. per day.

In 1955 the U.K. imported in round figures 207 million barrels of crude oil and 68 million barrels of refined products. Of this total about 56 per cent passed through the canal. The value, including cost, insurance, and freight, of Britain's imports of oil and products totaled $940,000,000 (£336 million). Imports valued at $417,000,000 (£149 million), 44 per cent of the total, came from Kuwait, Bahrain, Qatar, and the Trucial States and from Aden. A further 10 per cent came from Iraq and Saudi Arabia—the major part of it was carried by pipeline to Mediterranean ports and shipped from there. About half the European oil imports (excluding U.K.) passed through the Suez Canal.

Canal getting crowded . . . At present the passage of tankers is beginning to approach the canal's total capacity. But following the completion of the program of improvement, now under way, the transit capacity will have increased to between 1,180 and 1,330 million barrels. The present work entails an

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annual outlay of $14,000,000 (£5 million).

Assuming that plans to enlarge pipeline capacity are also proceeded with, the Suez Canal should be able to cope with all demands made on it by 1965. But, by 1975 there may be 2,200 to 2,600 million barrels of crude oil seeking south-north passage through the canal, an amount much in excess of likely capacity.

Transit dues paid by tankers using the canal are at the rate of about $0.13 per barrel for laden ships, and $0.44 per ton for those in ballast. These dues are roughly the equivalent of a further 1,000-mile journey. The larger tankers (45,000 d.w.t.) are not able to pass through the canal when carrying to capacity. From the Perisan Gulf to the U. S. East Coast the distance round the cape is 12,000 miles, some 3,600 miles longer than through the Suez route. Against this, transportation is more economical the bigger and faster the tanker. It is cheaper per ton of oil moved to send a very large tanker (say 40,000 d.w.t. plus) to the East Coast of the U. S. via the cape than a standard-sized vessel through the Suez Canal.

The main drawback of the cape route pertains to the extra time taken. The passage from the Persian Gulf to the U. S. takes half as long again via the cape. If, with the introduction of nuclear power, speeds of 30 knots could be obtained, the importance of the time factor would be very much reduced.

As far as oil transportation to the U.K. is concerned, it is reckoned that a tanker going round the cape would have to be more than twice the size as the one using the canal to make the voyage at comparable cost. But at present there are only limited facilities in Britain for discharging very large tankers. In order to move the same quantity of oil via the cape, oil companies might have to increase their tanker fleets by as much as 50 per cent. Tank charter agreements now include provisions for conveying oil by the cape route should passage of the Suez Canal become impossible.

Today the alternative means of moving Middle East oil to Europe and the East Coast of the U.S.A. are by tanker through the Suez Canal, tanker round the cape, or by pipeline. In 1955 the pipeline from Kirkuk in Iraq to Tripoli in Lebanon took 60,000,000 bbl., the line from Kirkuk to Banias, 129,000,000 bbl., and Trans-Arabian line 113,000,000 bbl. The construction of four new pumping stations, midway between the existing five, should lift the capacity of Tapline to 150,000,000 bbl. by 1958. A further 125,000,000 bbl. of annual capacity should be added by the building of further pipelines from Iraq.

Tables 1 and 2 indicate production of oil by the Middle East companies, and shipment of oil products through the Suez Canal.

During the 12 months ending last June Middle East oil production was approximately 1,182 million barrels. Of this total nearly 890 million barrels went to the Mediterranean, of which some 295 million barrels was delivered by pipeline, and twice that tonnage by tankers through the Suez Canal. Almost all the oil reaching the Mediterranean was destined for Western Europe. Between June 1955 and 1956 the main Middle East producers exported the following quantities: Iraq and Qatar, 288 million barrels; Kuwait, 414 million barrels; Iran, 148 million barrels; and southern Arabia, 340 million barrels.

Some of the largest tankers now in use of 45,000 d.w.t., while able to use the Suez Canal, cannot pass through it fully loaded. And tankers now under construction, or projected, of 60,000 and even 80,000 d.w.t., would suffer from the same handicap.

The three pipelines carrying oil from Kirkuk and Mosul fields to the eastern Mediterranean pass through Syria. In November 1955, the Iraq Petroleum Co. (I.P.C.) reached agreement with Syria on the revision of its transit pact. The supplemental agreement, calling for the government to share in the pipe-

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line profits, was ratified by the Syrian Parliament on December 5 last year. Similar terms were offered to Lebanon, through which 56,000,000 bbl. of oil cross 20 miles of its territory annually to the Tripoli terminal. Unfortunately no agreement has yet been reached with this government, and the project to lay a pipeline link to more than double throughput of Iraq oil to Tripoli is, therefore, held up.

Late last June the Lebanese Parliament passed a law aimed at subjecting I.P.C. to income tax, in violation of the company's 1931 convention. In introducing this legislation the minister responsible for oil transit negotiations contrasted I.P.C.'s offer made in December 1955 of payments calculated on a ton-mile basis, with an offer of Tapline to share equally with the government the profitability of its operation. The offer made by I.P.C. was equivalent to 50 per cent of the profit from its operations in Lebanon, on terms akin to those agreed to with Syria late last year.

Exhorbitant demands . . . The Lebanese Government, however, insists that for the 20 miles of its pipelines in its territory it should receive the same amount

TABLE 1—MIDDLE EAST OIL PRODUCTION, 1955

(In millions of barrels)

Kuwait oil	405
Arabian-American oil	351
Iraq Petroleum	179
Iranian Oil Exploration and Producing	120
Basrah Petroleum	54
Qatar Petroleum	40
Bahrain Oil	11
American Independent Oil)	
Getty Oil)	10
Mosul Petroleum	10
Khanqin Oil	3

TABLE 2—SHIPMENT OF OIL PRODUCTS THROUGH THE SUEZ CANAL

(In millions of barrels)

	Oil production 1955	Shipments through canal	Percentage of output shipped through canal
Kuwait	405	315	78
Saudi Arabia	351	50	14
Iraq	250	29	12
Iran	117	37	32
Qatar	40	29	72
Other countries		37	

Syria gets for the 263 miles of the same pipelines traversing that kingdom. In other words, the Lebanese proposal would have the effect of making Iraq oil exported through Lebanon more expensive than the same amount shipped through the alternative route with a Syrian terminal.

To this proposal the I.P.C. cannot agree. But it stands by the offer to apply to Lebanon the formula recently agreed with Syria. As late as January 1955, it entered into an agreement with Lebanon, the result of which was to triple its previous payments and its offer of December 1955 doubled this amount.

Despite many difficulties in getting previous agreements with the Lebanese Government implemented, I.P.C. has been planning a new pipeline to Tripoli in the hope that accord might shortly be reached by the parties concerned. This would have further increased the government's revenues, but it looks as though this project will have to be abandoned, and an alternative outlet for Iraq oil found.

It is surmised that oil circles in Lebanon are hoping to come to some agreemnet on lines similar to Tapline's proposal for a 50-50 division of profits with the Arab states through which its pipeline runs. So far, however, no firm understanding by the four states concerned—Lebanon, Jordan, Syria, and Saudi Arabia—on the precise way of dividing their half-share has been reached. And Lebanon, with the smallest pipeline mileage, still hopes for an equal share of the profits. Under its latest law new taxation will be assessable on I.P.C.

But government sources hint that they anticipate the arrival of an I.P.C. delegation to settle matters in a mutually beneficial way. Designers, build-

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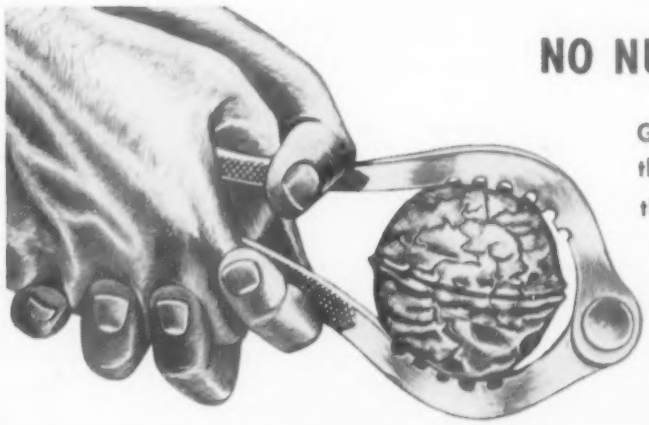
ers and operators of pipelines in the Middle East have done their best. But it is a regrettable fact that the economic climate is proving adverse, in the sense that the sanctity of contracts willingly entered into is being dishonored.

It was, therefore, not surprising that Tapline affirmed early in August that it was not prepared to continue negotiations with Lebanon on its recent offer of a half-share of profits for distribution among the four Arab states through which Tapline passes.

Tapline felt that the new law imposing retroactive taxation on foreign companies, previously enjoying exemptions under special agreements, was a violation of the convention under which it has been operating. It has not, however, withdrawn its offer on profits, but considers that the latest Lebanese legislation poses a new situation, in which negotiations with the country cannot be continued.

Ben-Gurion, the Israeli premier, stated, on August 7, that British and American interests were holding talks with Israel on the construction of a pipeline from Haifa to Elath in the Gulf of Agaba. This would cost about $30,000,000 and carry about 82,000 bbl. per day.

Israel's own oil supplies have not been coming through the Suez Canal since the Egyptian blockade began in 1951, but 82,000 bbl. per day represents the current capacity of the Haifa refinery. This pipeline would take a year for completion.



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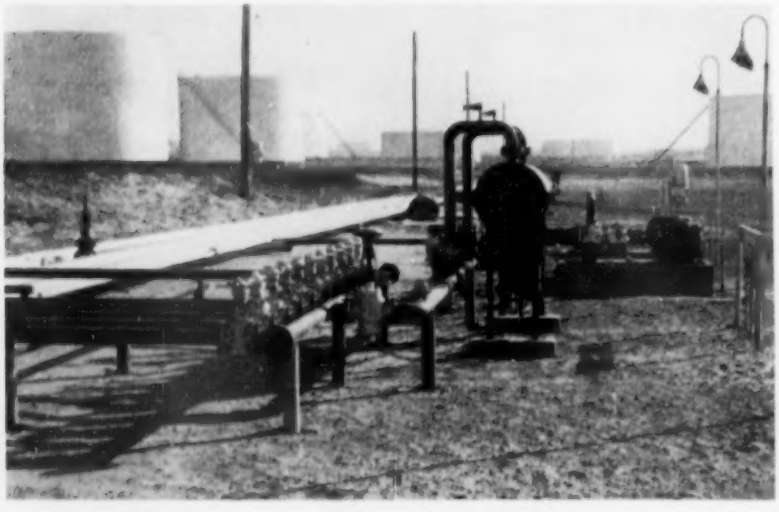


Will Pump Both Ways

by R. H. Latham
Pipe Line Technologists, Inc.

COSDEN PETROLEUM CORP.'S new products pipeline between Big Spring and Abilene, Tex., is unusual in several ways. It is the only products pipeline in the area; it is designed for pumping both ways; it is another line serving Air Force installations; and it is designed initially for a very moderate throughput.

Shortly after the end of World War II, Cosden built a small products terminal to serve the Abilene, Tex., area. All products were moved to this terminal from the company's refinery at Big Spring by railroad. As business increased, a cheaper and more efficient method of transporting products to the terminal had to be found.

In September 1955, Pipe Line Technologists, Inc., was engaged by Cosden to prepare a feasibility report and economic study as well as make an estimate of the cost of constructing a pipeline and pump station and making terminal improvements.

This study showed that such a line was economically sound. Accordingly, Pipe Line Technologists, Inc., was retained by Cosden to act as agent for the design, engineering, and construction of the line and associated improvements. The line is 6-in. A.P.I. 5LX42 pipe with 0.188-in. wall thickness. Coating is asphalt primer and dope with a single wrap of 8-lb. asbestos felt.

Two-way line . . . The line was designed so that flow may be reversed. This feature is necessary in case other refineries in the area elect to use Cosden's facilities to deliver jet fuel to Webb Air Force Base at Big Spring.

All material was ordered in October 1955, and on October 17 purchase of right-of-way was begun. The material started arriving on job site in early January 1956, and purchase of right-of-way had progressed so well that construction was started January 17.

The usual West Texas severe dust storms and sudden heavy rain storms kept construction from getting dull. One especially heavy rain flooded a highway and covered one of the contractor's trucks so that only the top of the cab was exposed. That night the wet driver was taken from the top of the truck cab by boat.

The line lies south of U. S. Highway 80 and roughly parallels Gulf and Magnolia lines. However, it was routed north of the new air base at Abilene. Necessary valving was installed to permit delivery of jet fuel as soon as approval was obtained to lay a mile-long, 4-in. lateral which would connect the air base tanks.

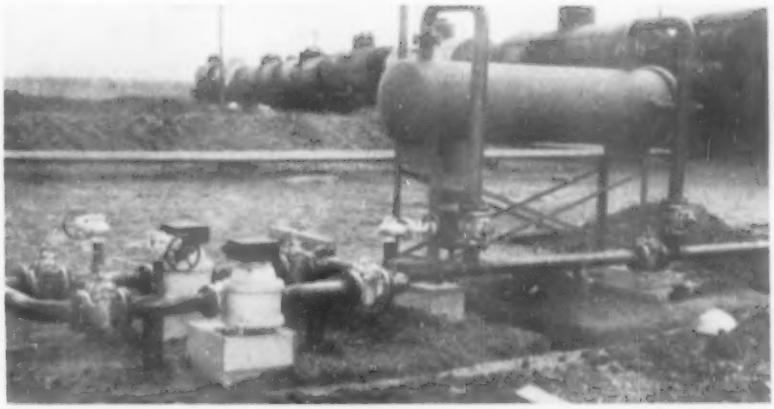
Caliche was encountered at varying depths throughout the entire line. The contractor, Holder Construction Co., of Snyder, Tex., used a big-inch ditcher with a rock wheel and small buckets to handle it. This worked so well that one ditcher could cut 10,000 ft. of ditch per shift. Construction proceeded on schedule and on May 15 the line was filled and delivery of products to the terminal was commenced.

Terminal Design

Originally the terminal storage consisted of three 10,000-bbl. tanks, one 1,000-bbl. tank, one 1,500-bbl. tank, and numerous small horizontal tanks.

The terminal was redesigned to handle eight grades of gasoline and two oils. Individual tanks, with necessary pump and separate fill and discharge lines were included in the design. All piping was to be aboveground. A new office was to be included and the warehouse space for tires, batteries, and specialty products was doubled.

Items that would take some time



STRAINERS AND METERS on the incoming stream at Abilene terminal. Railroad tracks were removed when line started up.

to obtain, such as meters, pumps, and tanks, were ordered before the engineering was complete.

All tanks were connected to two lifter-roof tanks for vapor conservation. Vapor space equal to 10 per cent of liquid storage space was provided. All tanks are designed to operate at 2-oz. pressure.

Ten products are now being handled at the terminal. In order to do this, extensive revisions of the piping at the two truck racks were required. Meters with printer heads, deaerators, strainers, flow-control valves, and stop-set mechanisms were installed. Now the products most handled may be loaded simultaneously on both sides of the rack. Other products may be loaded on either side, but not at the same time. Experience has proved that this will not delay truck loading and will keep investment at a minimum.

The use of this modern equipment permits the rackman to load two trucks at the same time. By using ticket printers, a permanent record is obtained of products loaded through each meter.

Due to space limitations and in order to keep investment cost to a minimum, only one tank is provided for each product. This requires close cooperation between terminal and dispatcher as time the product spends en route is about 9 days. This is particularly true on fast-moving products as only 7 days storage is available at the terminal.

The incoming stream is metered through a temperature-compensated meter, and goes through the customary strainers before storage. This is necessary for good control since only one tank is provided for each product, and it also provides a check on receipts.

Construction of the terminal required careful coordination with operations, as products were received by tank car every other day. The fumes present during tank-car unloading operations restricted area in which welding could be done. At the same time, truck-loading operations could not be stopped, or even delayed. This problem was solved by extensive prefabrication of piping and long hours of work while the terminal was closed over the week end. So well was this operation scheduled that no truck was delayed in loading and transition of supply from tank car to pipeline was accomplished over the week end, as planned. The railroad tracks were then removed to provide space for new tankage required in new terminal design.

Pump station . . . The electric-powered

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centrifugal pump station was designed to deliver 210 bbl. per hour with single pump operation or 315 bbl. per hour with two pumps operating in series. By changing pumps, this may be increased to a maximum of 550 bbl. per hour. To reduce spare-parts inventory and facilitate maintenance, all pumps are identical to existing refinery process pumps.

The pump station is in the open and is unattended, being provided with the usual shutdown devices. Products are metered into line through temperature-compensated meters, which provides a check on receipts of terminal.

As this was Cosden's first products line, experienced operating personnel from Pipe Line Technologists, Inc., were made available to instruct Cosden personnel how to operate the pipeline. In addition, an operating manual, covering all phases of scheduling, dispatching, reports, and operations was prepared and thoroughly discussed with the operators.

All dispatching is done by personnel of Cosden's refinery yield department. At the pump station, products are switched and the necessary reports are kept by one of the refinery pumpers so that no additional personnel were required to operate the pipeline and pump station.

THE AUTHOR

R. H. Latham is senior design and construction engineer for Pipe Line Technologists, Inc., Houston. As such, he is in charge of all field inspection and supervision of construction for the firm. Latham, 42, is a native of Missouri, is a graduate of Missouri School of Mines, and holds a master's degree from Purdue University. Early experience includes being resident engineer for Great Lakes Pipe Line Co. on construction of terminals and pump stations, and later assistant chief engineer for Mid-Continent Pipe Line Co. In 1950 he joined Mannix, Ltd., of Calgary, Alta., as western area engineer, and came with Pipe Line Technologists in 1953 as a project engineer.

Second air base line . . . Late in February 1956, Cosden decided to lay another line from their refinery to the ATC Webb Air Force Base in Big Spring. Steel was difficult to obtain, but fortunately, sufficient 5½-in. mill reject well casing was located to use on this line. This pipe had been hydrostatically tested to 3,000 psi. at the mill and could readily be used for line pipe.

Many difficulties, all out of proportion to its 8-mile length, were encountered, as the air base was on the opposite side of Big Spring from the refinery. The line has 4 miles laid in the city streets. Old, unchartered service lines that couldn't be found with a pipe locater were encountered every day.

Only a few blocks of ditch could be opened at a time, and the yard wrapped pipe was immediately strung, welded and lowered in.

Portable timber bridges were provided so that all street crossings and driveways could always be used during construction.

Early in May, approval was received to connect the products pipeline to both air bases, and this was immediately started and was completed in about 2 weeks. All tank tiein work at the bases had to be done on week ends so that routine training operations of the base would not be affected.

The line to Webb Air Force Base will handle only jet fuel, so its operation will be routine.

In delivering jet to Abilene Air Force Base, the procedure previously established by the engineers and Quality Control of Air Materiel Command for common-carrier pipeline deliveries to Smoky Hill Air Force Base at Salina, Kans., will be used.

Each tender of jet fuel will be buffered by special refinery stock and the commingled products will be delivered to Abilene terminal and blended off in regular gasoline.

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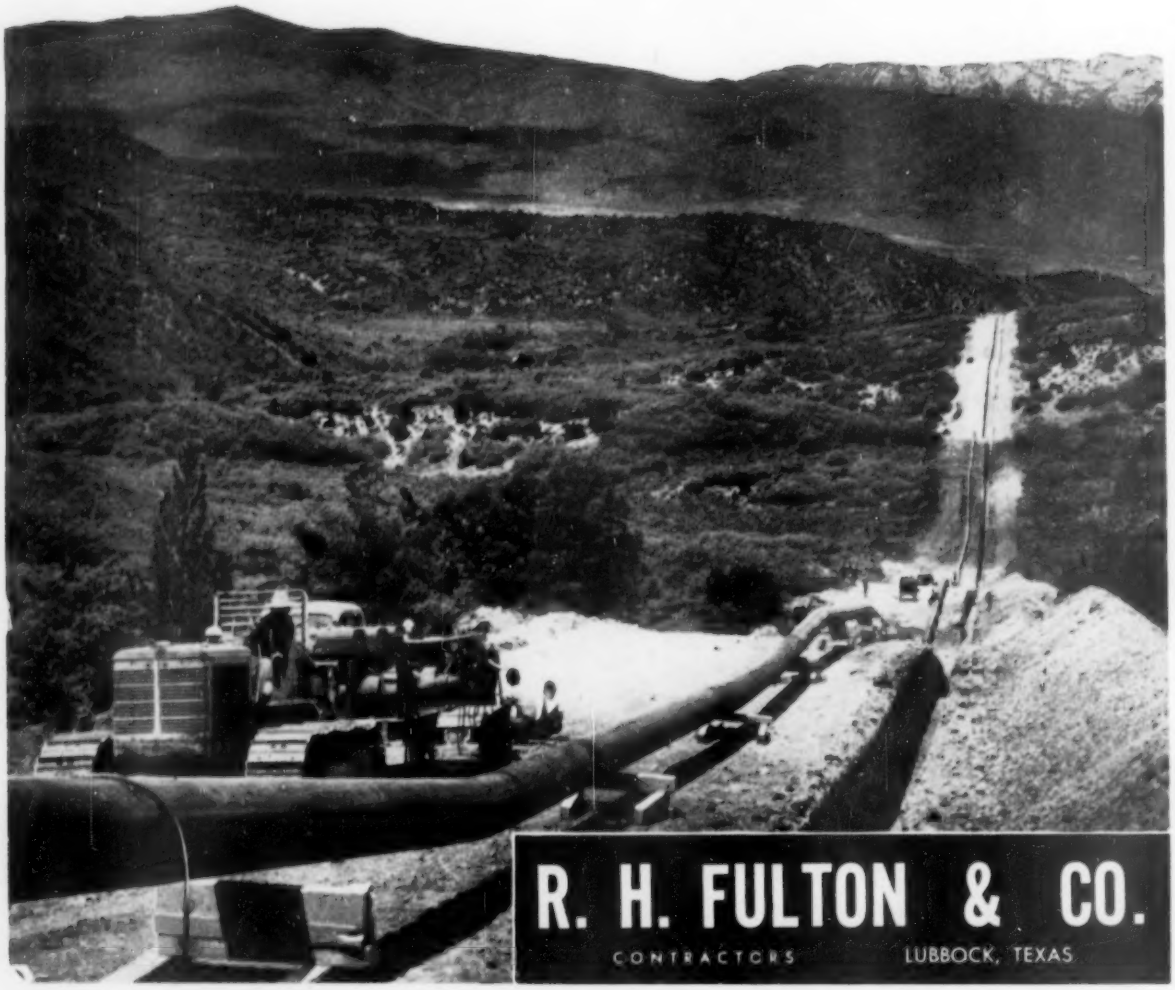

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Pipeline Patrol

. . . Report on Construction

Under Way, Contracted, and Planned

PIPELINE activity reported here is compiled from surveys conducted by The Oil and Gas Journal among pipeline companies and contracting firms. Projects listed include those proposed, contracted, and under way. Uncontracted projects are indicated by • preceding the project.

Crude-Oil Pipelines

Buckeye Pipe Line Co.—Will complete in October or November 1956, own reconditioning of 191 miles of 8-in. from Griffity, Ind., to Lima, Ohio.

Fulton, R. H. & Co., Lubbock, Tex.—Has applied to Wyoming Public Service Commission to build 20 mile 6-in. line from Donkey Creek field near Moorcroft, Wyo., to Butte Pipe Line Co.'s line. (Application competes with that of Powder River Pipeline Co.)

• **Gulf Oil Corp.**—Will build 33 miles of 8-in. from Citronelle field to Mobile, Ala.; completed.

Lakehead Pipe Line Co., Inc.—Anderson Brothers Corp. has under way 51 miles of 26-in. looping from Viking to Plummer, Minn., to complete August 31, 1956. It is in conjunction with 69 miles of 24 and 26-in. to be completed this summer by Interprovincial Pipe Line Co. (See Interprovincial, foreign crude.)

• **Magnolia Pipe Line Co.**—Plans 36 miles of 12-in. from Andrews to Midland, Tex., to be completed January 1, 1957.

Northwest Pipeline Corp. (an affiliate of Pacific Northwest Pipeline Corp.)—Will build 350 miles of 8-in. crude and products line from Four Corners area to Salt Lake City, to be completed August 1957.

• **Offshore Gathering Corp., Houston.**—Proposes 364 miles of mostly 20-in. in Gulf of Mexico off Louisiana.

• **Pasotex Pipe Line Co.**—Plans 127 miles of 20-in. along its route from Wink to El Paso, retiring another dual 8-in. section, to complete July 31, 1957.

• **Powder River Pipeline Co.**—Fratt Building, Billings, Mont., plans a 20-mile, 6-in. line from Donkey Creek field near Moorcroft, Wyo., to Butte Pipe Line Co.'s line.

• **Shannon Oil Co., Denver.**—Plans with Farmers Union Central Exchange, Inc., and Mule Creek Oil Co., both of Billings, Mont., a 34-mile, 6-in. line from Murphy Dome in Hot Springs County, Wyoming, to contact Ohio Oil Co.'s line in Big Horn County. Construction to start in August, end by December 1, 1956.

• **Shell Pipe Line Corp.**—Has let contract for 41.5 miles of 10-in. from Shell's Houston refinery to Brookshire Station, to complete by December 1, 1956. Bill Murry is spread superintendent for Bill Murry & Co., contractors. Spread office: 12629 South Main, Houston 25, Tex.

• **Sinclair Pipe Line Co.**—Plans 150 miles of 20-in. from Teague, Tex., to Houston.

• **Tecumseh Pipe Line System.**—190 miles of 20-in. will be built by Sinclair Refining Co., Pure Oil Co., Ashland Oil & Refining Co., between East Chicago and Cygnet, Ohio, to be completed September 1957.

• **Union Oil Co. of California.**—Proposes 815-mile line from Rifle, Colo., to Los Angeles refining area, to carry products from its proposed Rifle shale-oil plant.

Will build 225 miles of 16-in. from San Joaquin Valley to its refinery at Oleum, Calif., to be completed late 1957.

Products Pipelines

• **American Pipe Line Co.**—Received ODM approval to amortize 40 per cent of $17,000,000 with a rapid writeoff on proposed line from Gulf Coast area to New York City area.

• **Cities Service Oil Co. & Subsidiaries.**—Plans a 10-mile, 6-in. L.P.G. line from Maysville to near Pauls Valley, Okla., to tie in to Shell line moving on to Cushing, Okla.

• **El Paso Natural Gas Co.**—Plans 240 miles of "larger than 6-in." to carry natural gasoline, butane, and propane, from its Midkiff natural-gasoline plant in Permian basin, Midland County, to El Paso.

• Will build 38-mile, 4-in. line from Wingate, N. M., to Prewitt refinery. To start in September.

• **Gulf Refining Co.**—Will build 45 miles of 8-in. from Pontiac Eastern Corp.'s planned refinery at Hattiesburg, Miss. (due on stream May 1957) to a connection with Plantation Pipe Line Co.'s system. No date set to start.

Magnolia Pipe Line Co.—Plans a 30-mile, 8-in. line from Andrews to Dollarhide, Tex., to complete January 1, 1957, and an L.P.G. line, 19 miles of 6-in., 3 miles of 4-in. from Beaumont to Orange, Tex. Brown & Root has under way a 75-mile, 8-in. L.P.G. line from Hull to Texas City, Tex., to complete January 1, 1957.

• **Phillips Chemical Co.**—Panama Williams Corp. has contract to build 76 miles of 6-in. from Pasadena to Sweeny, Tex., for L.P.G., to complete by September 1, 1956. Spread office is in South Houston, and W. H. Shiflett is spread superintendent.

• **Phillips Petroleum Co.**—Plans 15 miles of 6-in. L.P.G. line in Sweeny, Tex., area.

• **Phillips Pipe Line Co.**—Plans 135 miles of 12-in. looping between Borger, Tex., and St. Louis, Mo., to be completed December 31, 1956.

Plantation Pipe Line Co.—Oklahoma Pipe Line Constructors has under way 327 miles of 18-in. from Baton Rouge to Helena, Ala., to complete December 1956, N. L. Arie, spread man, office at Baton Rouge.

• **Shell Oil Co., Pipe Line Department, Pacific Coast.**—Plans to convert 13 miles of existing 4-in. gasoline line, and add 3 miles of new line, to move gasoline from Wilmington refinery to Los Angeles. To be completed January 1, 1957.

• **Sioux Oil Co.**—Plans 80 miles of 4-in. from its Newcastle, Wyo., refinery to Rapid City, S. D., to be completed late 1956.

• **Sohio Petroleum Co.**—Plans 37 miles of 8-in. from Mogadore to Girard, Ohio, to complete November 1, 1956.

• **Southern Pacific Pipe Lines, Inc.**—Plans a 300-mile line to span the Sierras and connect San Francisco with Reno and Fallon, Nev., and to serve the Sacramento Valley.

Sun Pipe Line Co.—Contracts let on 109 miles of 14-in. from Twin Oaks, Pa., to Newark, N. J.: Sheehan Pipe Line Construction, 90 miles from Twin Oaks to Plainfield, N. J., J. W. Brown, spreadman, office at Mal-

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FLASHER PANEL - Automatically flashes Beacon Lamps — with balanced load provisions.
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Models also available with separate Alarm Signal for each Beacon Lamp.
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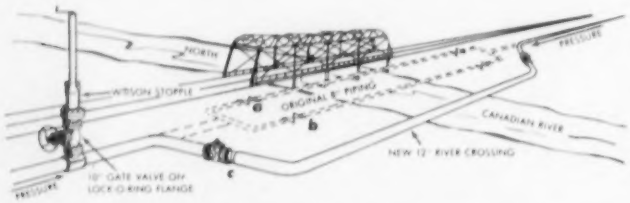
OKLAHOMA NATURAL GAS COMPANY MAINTAINED GAS SERVICE TO OKLAHOMA CITY CUSTOMERS WHILE RELOCATING A SECTION OF PIPELINE CROSSING THE NORTH CANADIAN RIVER . . .

HERE'S HOW THE JOB WAS DONE

① TWO 10" FLANGED SPLIT-TEES WERE WELDED TO THE LINE ON EITHER SIDE OF THE RIVER



② TAP WAS MADE WITH WmSON-HILLCO MODEL 660 TAPPING MACHINE

③ WmSON STOPPLE REPLACED TAPPING MACHINE ON CLOSED VALVE

④ LINE WAS PLUGGED ISOLATING SECTION BETWEEN STOPPLE AND VALVES a. & b. (CITY LOOP SYSTEM MAINTAINED SERVICE TO RIVER FROM EACH SIDE.)

⑤ ISOLATED SECTION WAS THEN CUT AND NEW 12" CROSSING TIED INTO 10" LINE

⑥ FOR REMOVAL OF VALVE, LOCK-O-RING PLUG WAS INSTALLED IN L-O-R FLANGE WITH TAPPING MACHINE

⑦ TAPPING MACHINE AND GATE VALVE WERE REMOVED AND BLIND FLANGE INSTALLED

THIS ENTIRE OPERATION WAS THEN REPEATED ON THE OPPOSITE SIDE OF THE RIVER

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Pipeline Patrol

vern, Pa.; Delaney-Missouri Valley Construction Co., remainder. Missouri Valley Dredging Co. has river crossings at Delaware, Schuykill, and Raritan rivers. Work started May 1, to end September 1956. Line replaces present 8-in. line. Sheehan will take up 75 miles of 8-in. when new line is finished.

Non-Petroleum Pipelines

• **American Gilsonite Co.**—Plans 70 miles of 6-in. from Bonanza, Utah, to Grand Junction, Colo., to carry slurry of gilsonite from mines to refinery now being built.

Pittsburgh Consolidated Coal Co.—Let to Williams Brothers, 108 miles of 10-in. from its mines in eastern Ohio to Cleveland Electric Illuminating Co.'s Eastlake power plant northeast of Cleveland. Completed.

Natural-Gas Pipelines

American Louisiana Pipe Line Co.—Let bulk of 1,160-mile line from North Tepetate, La., to Detroit. H. C. Price and Houston Contracting Co. have 770 miles of 30-in. from near Willow Run, Mich., to near Eudora, Ark. Majority of work completed.

Houston Contracting Co. started August 1, on 21 miles of 24-in. from Tepetate to Lewisburg, La., R. E. Thornton, supt., office at Eunice. Completed.

Houston Contracting Co. and H. C. Price Co. waiting on pipe to start 121 miles of 22-in. from Payne, Ohio, to Bridgman, Mich. Will start this year if pipe available before winter weather. Houston to lay 75 miles on east end, E. C. Norris, spread man. Price to lay 46 miles on west end.

• **Arkansas Louisiana Gas Co.**—Has long-range plans for line from Texas-Louisiana coastal region to northern Louisiana, to connect with their present system.

Atlantic Seaboard Corp.—Williams-Austin Co. has under way 50 miles of 24-in. from Hardy County, West Virginia, to Greene County, Virginia, O. L. Martin, spread man, office at Elkton, Va., and 32 miles of 26-in. loops along the Cobb-Rockville line in West Virginia. Ralph Gaddy, spread man, office at Elkins, W. Va., both to be completed November 1, 1956.

• **Carolina Pipeline Co.**—Has received South Carolina Public Service Commission permit to distribute gas in central South Carolina. Plans lines to 14 cities. Will buy gas from Transcontinental Gas Pipeline Co. or Southern Natural Gas Co.

• **Cities Service Gas Co.**—Plans 12 miles of 30-in. and 17 miles of 20-in. between Oklahoma City and Mulhall, Okla., to be completed October 1, 1956.

Prairie Construction Co., Inc., has 28 miles of 16-in. between Leavenworth, Kans., and St. Joseph, Mo., to complete August 15, 1956; 9 miles of 16-in. near Springfield, Mo., to complete October 1, 1956; 4 miles of 12-in. from Johnson County to Lafayette County, Missouri, to complete September 1, 1956.

• **Coastal Transmission Corp.**—Applied to FPC for 565 miles of 22-26-in. from McAllen, Tex., to Baton Rouge, to deliver to Houston Texas Gas & Oil Co.'s proposed line to Florida. Plans 272 miles of smaller gathering lines.

• **Colonial Natural Gas Corp.**—Proposes two systems: One between Houston-Lake Charles area and Miami, Fla.; one in the Carolinas and Georgia.

• **Colorado Interstate Gas Co.**—R. H. Fulton has 238 miles of 22-in. from Laramie to Green River, Wyo. (last part of a 374-mile line between Denver and Rock Springs), to be completed fall 1956. Filed, March 29, for FPC permit for 1957 program: 307 miles of 30-in. from Idalia, Colo., to Beatrice,

Pipeline Patrol

Neb., to take gas from a planned 165-mile, 26-in. line from near Carr, Colo., to Idalia, and from a 72-mile, 26-in. line from near Kit Carson, Colo. to Idalia; 215 miles of 20 and 24-in. to parallel present line from Texas Panhandle area to Kit Carson; 34 miles of 16-in. from Keyes field, Oklahoma, and Greenwood field, Kansas, to the new north-south line.

El Paso Natural Gas Co.—Has under way 193 miles of 34-in. between San Juan basin and Topock, Ariz., and 38 miles of 20-in. between San Juan mainline and Phoenix, both to be completed February 1, 1957. Western Pipeline, Inc. has under way 146 miles of 34-in. between San Juan basin and Topock, to be completed February 1, 1957, and 112 miles of 20-in. between San Juan mainline and Phoenix, to be completed November 1, 1956. El Paso also has under way 34 miles of 24-in. from Ignacio, Colo., to the Blanco plant, to be completed October 1, 1956.

Filed June 1956 for FPC permit for 888 miles of field and main lines in Texas, New Mexico, and Arizona.

Has FPC permit for 28 miles of 10-in. line in Nolan and Coke counties, Texas.

• **Houston Texas Gas & Oil Co.**—Applied to FPC for 960 miles between Baton Rouge and Miami: 507 miles of 30-in., 157 miles of 26-in., 61 miles of 20-in., 224 miles of 18-in., 12 miles of 12-in. Plans 500 miles of sales laterals in Florida, with main line joining Coastal Transmission's proposed line from McAllen, Tex., to Baton Rouge.

• **Iron Ranges Natural Gas Co., St. Paul.**—Applied to FPC for a 68-mile transmission line and 47 miles of laterals to supply towns on the Mesabi Iron Range, Minnesota.

• **Lone Star Gas Co.**—Has two plans before FPC to enlarge system in Texas and Oklahoma: one is a 230-mile line from Cotton County, Oklahoma, to Fritch, Tex.; one is a 205-mile line from Snyder, Tex., to a hookup with the Cotton-Fritch line. Plans are attempt to keep Natural Gas Pipeline Co. of America from building line from Wise County, Texas, to Fritch.

Michigan Consolidated Gas Co.—Somerville Construction Co. has under way 67 miles of 10 and 12-in. between Sears and Travers City, Mich., Floyd Huduall, superintendent, office at Cadillac. Somerville, jointly with H. L. Gentry Construction, has under way 60 miles of 10 and 12-in. between Muskegon and Ludington, Mich., Frank Morris, superintendent, office at Hart.

• **Michigan Wisconsin Pipe Line Co.**—Has FPC permit for 252 miles of 24, 18, 12, 6, and 4-in. loops in Wisconsin, to be completed November 1956.

Latex Construction Co., jointly with Houston Construction Co. and H. C. Price Co., has 90 miles of 16 and 20-in. between Milwaukee and Oshkosh, to start June 25 and complete October 1, 1956, John Phipps and U. J. Davenport, spread men, office at Fond du Lac.

H. C. Price Co. and Houston Contracting Co. will build 149.4 miles of loop lines in Wisconsin and Illinois. Price will construct 56 miles of 24-in., and Houston will build 42.4 miles of 20-in. and 51 miles of 16-in. (being handled by Latex Construction Co. of Georgia, office at Fnd du Lac, Wis.

• **Midwestern Gas Transmission Co.**—Will build a main line from Portland, Tenn., to Canadian border near Emerson, Man.; 829 miles of 24-in., 109 miles of 16-in., 174 miles of 12-in. Plans 648 miles of 3 to 18-in. extensions in Minnesota and Wisconsin, pending FPC approval.

Montana Power Co.—O'Conner Construction Co., Fromberg, Mont., has contract for 75 miles of 6-in. from Big Coulee field to Lewistown and Harlowton, Mont. Starts September 1.

• **Natural Gas Pipeline Co. of America.**—Has FPC approval for 350 miles of 20 and 26-in. from Jack and Wise counties, Texas, to Fritch, Tex., which will be contested by Natural Gas Pipeline and Lone Star Gas Co. Filed for FPC permit for a 389-mile, 36-in. loop along its line from Beatrice, Neb., to Chicago, to take gas from proposed line of Colorado Interstate Gas Co. Also for 91 miles of 30-in. looping to be laid along parts of its main line.

Niagara Mohawk Power Corp.—Let to various contractors, 275 miles of 2 to 12-in. distribution mains for growth of service areas in Central, Eastern, and Northern New York, to be completed December 31, 1956.

• **North Carolina Natural Gas Corp.**—This subsidiary of Colonial Natural Gas Corp. has permit from North Carolina Utilities Commission for 575 miles of 3 to 16-in. from Transcontinental Gas Pipe Line Corp.'s system near Mooresville, eastwardly across North Carolina.

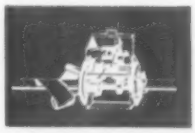
• **Northern Natural Gas Co.**—Applied to FPC to add 348 miles of main line, 307 miles of branch lines in Wisconsin, Minnesota, South Dakota, and Iowa. Main lines include 169 miles in Duluth-Superior area, 164 miles in Aberdeen area of South Dakota.

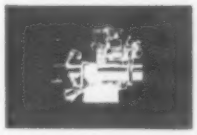
R. H. Fulton & Co. has 28 miles of 20-in. from Redfield to Ogden, Iowa; Beaver Creek and North Racoon crossings; 15 miles of 24-in. north and south of Hooper, Nebraska.

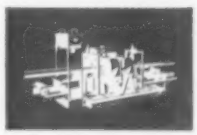
Pentzien, Inc., has 24-in. Elkhorn River crossing.

Plans 73 miles of 20-in., Savanna Creek to Pincher Creek fields in Alta., Canada; 32 miles of 24-in. from Pincher Creek to Montana border; 1,100 miles of 26-in. from Montana into Minneapolis.

REMCO PIPELINE EQUIPMENT







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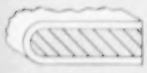
2 Milled-center. Machined from outside diameter. Provides flat surface flush with pipe I.D. reduces impedance to flow.



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Pipeline Patrol

• **Offshore Gathering Corp., Houston.**—Seeks FPC permit for 364 miles in Gulf of Mexico off Louisiana: 60 miles of 24-in.; 70 miles of 26-in.; 234 miles of 30-in.

• **Pacific Gas & Electric Co.**—Will build 37 miles of 20-in., 37 miles of 18-in., 9 miles of 12-in. from Beehive Bend field near Willows, Calif., to near Davis, then to Sacramento. Has under way a 6-mile gathering system at Beehive Bend. Also plans to loop the Topock-Milpitas line with 135 miles of 34-in., laying major part in 1956, and 62 miles in 1957. A joint-venture firm, Midwestern-Johnson-Dixon, has 85 miles of this to complete in 1956.

• **Pacific Northwest Pipeline Corp.**—Has FPC permit for 37 miles of 6-in. from Dove Creek, Colo., to Nucla, and 13 miles of 4-in. from Nucla to Uravan, to serve Union Carbide Nuclear Co. and Vanadium Corp. of America. Work under way on other trunk and sales laterals:

R. H. Fulton & Co., 156 miles 20 and 16-in. lateral from main line to Spokane; also 129 miles of laterals into Idaho, to complete fall 1956.

• **Phillips Chemical Co.**—Plans 79 miles of 6-4-in. ethylene line from Sweeny to Pasadena, Tex., to be completed December 31, 1956.

• **Piedmont Gas Co., Hickory, N. C.**—(Parent is Carolina Natural Gas Corp.) Seeks FPC permit for 78 miles of 2 to 8-in. extension off Transcontinental in North Carolina, to serve Gaston, Lincoln, Catawba, Caldwell, and Burke counties.

Portland Gas & Coke Co.—United Engineers & Constructors, Inc., of Philadelphia, has engineering contract for 80 miles of various size lines up to 16-in.

Signal Oil & Gas Co.—C. P. Bartley & Son has 70 miles of 2 to 16-in. gathering system near Tioga, N. D., to be completed September 1, 1956. C. P. Bartley, Jr., and Lawrence Barto, spread men, office at Tioga.

Southern California Gas Co. and Southern Counties Gas Co. of California.—R. H. Fulton & Co. has contract to lay 241 miles of 30-in. from the outskirts of Los Angeles to Topock on the Arizona-California border. Right-of-way and ditch starts in October, pipe in January. Line to be completed in June 1957.

Also building 49 miles of 30-in. from Newhall to Alhambra, Calif. Work is under way by: Alex Robertson Co., 13 miles; Macco Corp., 16 miles; Joe E. Young Contractors, Inc., 19 miles. To be completed December 1, 1956.

• **Southern Natural Gas Co.**—Has temporary FPC authority for 39 miles of loops near Atlanta, Ga.

• **Tennessee Gas Transmission Co.**—1—Bechtel Corp. has 74 miles of 30-in. looping from Glasgow to Danville, Ky., to complete by October 1, 1956, Joe L. Work, spread man, office at Greensburg, Ky.

2—142 miles of 26-in. looping in Ohio, to be completed fall 1956, under contract to: H. C. Price, 81 miles from near New Boston to near McConnelsville, G. A. Reutzel, spread man, office at Chauncey (30 miles completed); Oklahoma Construction Co., 61 miles from near Newcomerstown to near Lisbon, office at Carrollton, Gene Gohring, spread man.

3—Has FPC permit for 63 miles of 30-in. looping from Scottsville, Ky., to Cave City, and from southwest of Danville to northeast of Danville.

4—Has FPC permit for 99 miles of 26-in. looping from Greenup, Ky., to north of Ohio River, from McConnellsville to Newcomerstown, and from Lisbon, Ohio, to near Mercer, Pa.

5—Houston Contracting Co. has 30 miles of 8 and 12-in. near Golden Meadow and

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TRANSCONTINENTAL GAS PIPE LINE CORPORATION

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Pipeline Patrol

Leeville, La. H. E. Murphy, superintendent. Pipe starts immediately.

• **Texas Eastern Transmission Co.**—Applied to FPC, December 1955, for 422-miles of 30-in. from McAllen to Beaumont, Tex., to move imported Mexican gas. Applied for 530 miles of 30-in. looping from Kosciusko, Miss., to Uniontown, Pa. Will lay 45 miles of 24-in. from Provident City, Tex., to connect in Matagorda County, Texas, to tie the Wilcox Trend Gathering System with the extension from Mexico.

Texas Gas Transmission Corp.—Houston Contracting Co. has 195 miles of work in Miss., Ark., and Southern La.: 22 miles of 30-in. and 10 miles of 18-in. reconditioning near Clarksdale, Miss., started August 1, W. H. Hayes, supt.; 31 miles of 30-in. and 10 miles of 18-in. reconditioning near Greenville, Miss., and Wilmot, Ark., started August 5, F. A. Silar, supt.; 122 miles of 20-in. to lay from Eunice, La., to East of Morgan City, La.; M. L. Thompson, supt.

Pentzien, Inc., has Mississippi River crossing near Greenville, Miss., to complete December 15, 1956.

• **Trans Carolina Pipe Line Corp.**, Commercial Building, Raleigh, N. Car.—Seeks FPC permit for 300-mile system across North and South Carolina, plus 500 miles of laterals.

• **Transcontinental Gas Pipe Line Corp.**—Has applied to FPC to lay 160 miles of 36-in., 67 miles of 30-in., and 24 miles of 24-in. loops from Louisiana to Pennsylvania, to be completed December 1, 1956; 25 miles of 36-in. loops from Louisiana to South Carolina, to lay in 1957. Has also applied for 31 miles of 36-in. and 43 miles of 30-in. line to be built during 1957.

• **Washington Gas Light Co.**—Has FPC approval to construct 26.1 miles of 24-in. and 2.7 miles of 20-in., from Dranesville, Va., to Washington, D. C.

Winchester and Vienna, Ill., Cities of—M. L. Hulcher Co., Inc., has 21 miles of 8-in. for Winchester, to complete September 30, 1956, Rolfe, superintendent.

Foreign Crude-Oil Pipelines

Arabian American Oil Co.—Firm is building a 140-mile, 20-in. line from Safaniya field to Ras Tanura.

• **Canadian Gulf Oil Co.**—Seeks approval for 35 miles of 8-in. to connect Drumheil field, Alberta, with existing Gulf lines running to Edmonton.

Cremona Pipe Lines, Ltd. — Dutton-Williams Brothers, Ltd., has 78-mile, 8-in. line from Sundre-Westward Ho region to Calgary, to be completed August 1956. Company is subsidiary of Home Oil Co. Spread office is in Calgary, and F. Peters is spread man.

Gulf Italia Co.—Will complete late summer 1956, 35 miles from its Ragusa field in southwestern Sicily to RASIOM's refinery at Augusta.

Interprovincial Pipe Line Co.—Majestic Contractors, Ltd., has under way 67 miles of 24-in. between Carroll and Somerset, Man.; 2 miles of 26-in. between U. S. border and Gretna pumping station, to complete August 31, 1956.

Has applied to Board of Transport Commissioners for 151 miles of 20-in., an extension of its line from Sarnia to Port Credit, Ont. If approved, work will start spring 1957, end that fall.

Peace River Oil Pipe Lines, Ltd.—Fulton Banister, Ltd., has contract to coat and bury 45 miles of 12 and 16-in. from Valleyview to Edson, Alta. (Line was welded above ground last year). Jerry Nash is superintendent, office at Valleyview. Completed.

Pembina Pipe Line, Ltd.—Sparling Davis Co., Ltd., has 100 miles of 3 to 10-in. gathering system in Pembina field.

Mannix, Ltd., has 200 miles of 3 to 12-in. gathering lines in Pembina field, F. Whitlow, superintendent, office in Pembina field.

PEMEX.—Constructora El Aguila, S. A., has 50 miles of 20-in. from Angostura to Veracruz, Antonio Sanz Polo, spread man, office at Veracruz.

• **Rangeland Pipeline, Ltd.**—Will build 17 miles of 6-in. and 16 miles of 4-in. from west end of Joffre field to connect West Gilby; 10 miles of 12-in. from Gilby Junction to Rimbey field, Alberta. Work to be completed fall 1956.

• **Royal Dutch-Shell**—Together with several other companies, is considering 700-mile line across Europe from the Mediterranean to the North Sea, running through Eastern France, Luxembourg, West Germany, the Netherlands, and Belgium. Main trunk would be 30-in.

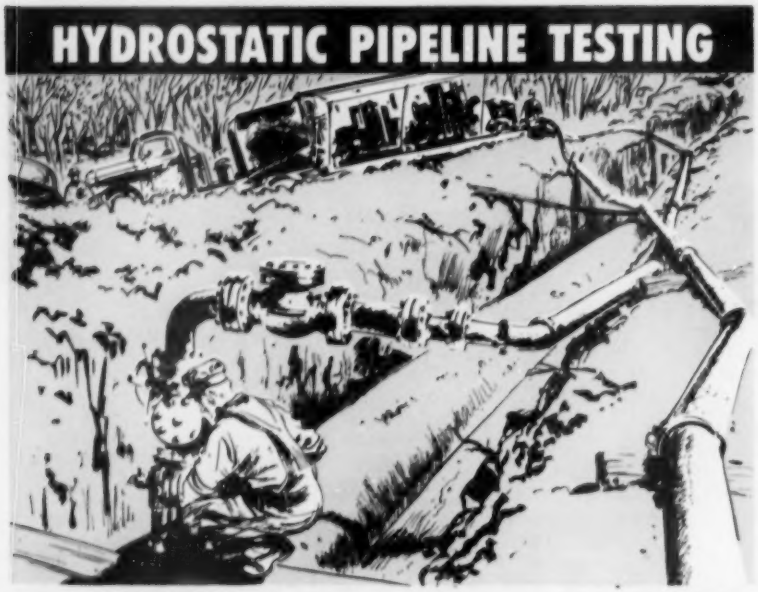
• **Sinclair Oil Corp. and Socony Mobil Oil Co.**—Will build 211 miles of 20-in. from the Silvestre field in Barinas, Venezuela, to Puerto Cabello on Caribbean Sea.

• **South Saskatchewn Pipe Line Co.**—Building 58 miles of 12-in. from Cantuar field to Dollard field in Saskatchewan, to be completed September 1956.

• **Texaco Exploration Co.**—Plans 22 miles of 12-in. and 3 miles of 8-in. between Westerose and Rimbey pools, Alberta, Can.

Union of Soviet Socialist Republic.—Has under way a 2,300-mile Trans-Siberian crude and products system from Ufa and the Tuimaza fields in Bashkiria to Irkutsk near Lake Baikal.

Westspur Pipe Line Co.—Majestic Contrac-



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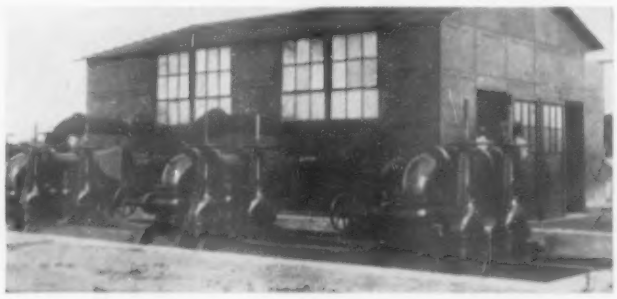

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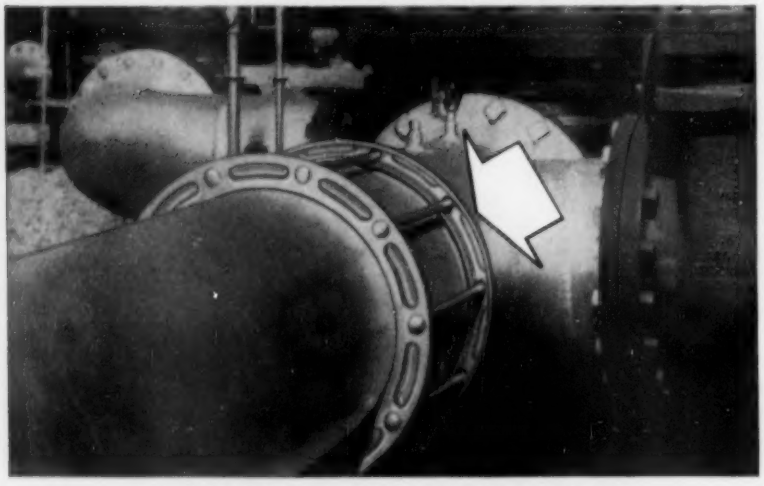

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Pipeline Patrol

tors, Ltd., has 109 miles of 12-in. from Midale, Sask., to Interprovincial Pipe Line Co.'s pump station at Cromer, Man., and 50 miles of various size gathering lines in Midale-Frobisher area, to complete fall 1956.

Yacimientos Petroliferos Fiscales (Argentina).—Has started 700 miles of 12-in. from Campo Duran to San Lorenzo. TECHINT, (Compania Tecnica Internacional), Buenos Aires, has 90 miles.

Yacimientos Petroliferos Fiscales Bolivianos (Y.P.F.B.)—Williams Brothers Co. has 160 miles of 10-in. and 43 miles of 8-in. from Sicasica to Arica on the Chilean coast, to be completed December 1957.

Foreign Products Pipelines

• **Estrada de Ferro Santos a Jundial Departamento Oleoducto.**—Plans 6 miles of 14-in. from the Capuava Refinery to Utinga Terminal, to be completed December 1956.

Hydrocarbons Pipeline Co. (subsidiary of Canadian Hydrocarbons)—Has permit from Parliament of Canada to build 800 miles of 6 and 8-in. L.P.G. line from near Edmonton, Alta., to Ft. William, Ont. If approved by Federal Board of Transport Commissioners and the Alberta Petroleum and Natural Gas Conservation Board, work will start early 1957. Williams Brothers, Calgary, and A. D. Little and Co., Boston will act as construction consultants.

• **Imperial Oil, Ltd.**—Will lay 38 miles of 12-in. loop along present line from Waterdown, Ont., to Toronto.

• **Iraq Petroleum Co., Ltd.**—Plans 75 miles of 24-in., 180,000-bbl. daily capacity, from Homs, Syria, to Tripoli, Lebanon.

• **Israeli Government.**—Will build 6-in. products line from Haifa to Tel Aviv.

National Iranian Oil Co.—Contracts let on 573 miles of 10-in., 40,000-bbl. daily capacity, from Ahwaz to Teheran, Iran; Constain-John Brown, Ltd., London, and Williams Brothers Co., started February 1956, laying southern 337 miles; Enterpose of Paris, has northern 236 miles.

• **North Atlantic Treaty Organization (NATO).**—Laying 2,000 miles of lines to airfields in parts of Europe. Associated Pipeline Contractors, Inc., has 450 miles from Iskenderun, Turkey, to Batman. TECHINT (Compagnia Tecnica Internazionale), Milano, Italy, has 205 miles of 4-in. from Bandirma to Eskisehir, Turkey, and 250 miles of 8-in. from Antalya to Eskisehir. Bids were taken in January 1956, on 300 miles of 12-in. between Marseille and Langres, France.

PEMEX.—Constructora El Aguila, S. A., has 155 miles of 12-in. from Tampico to Cd. Victoria, Geronimo Aviuchastegui, spread man, office at Tampico.

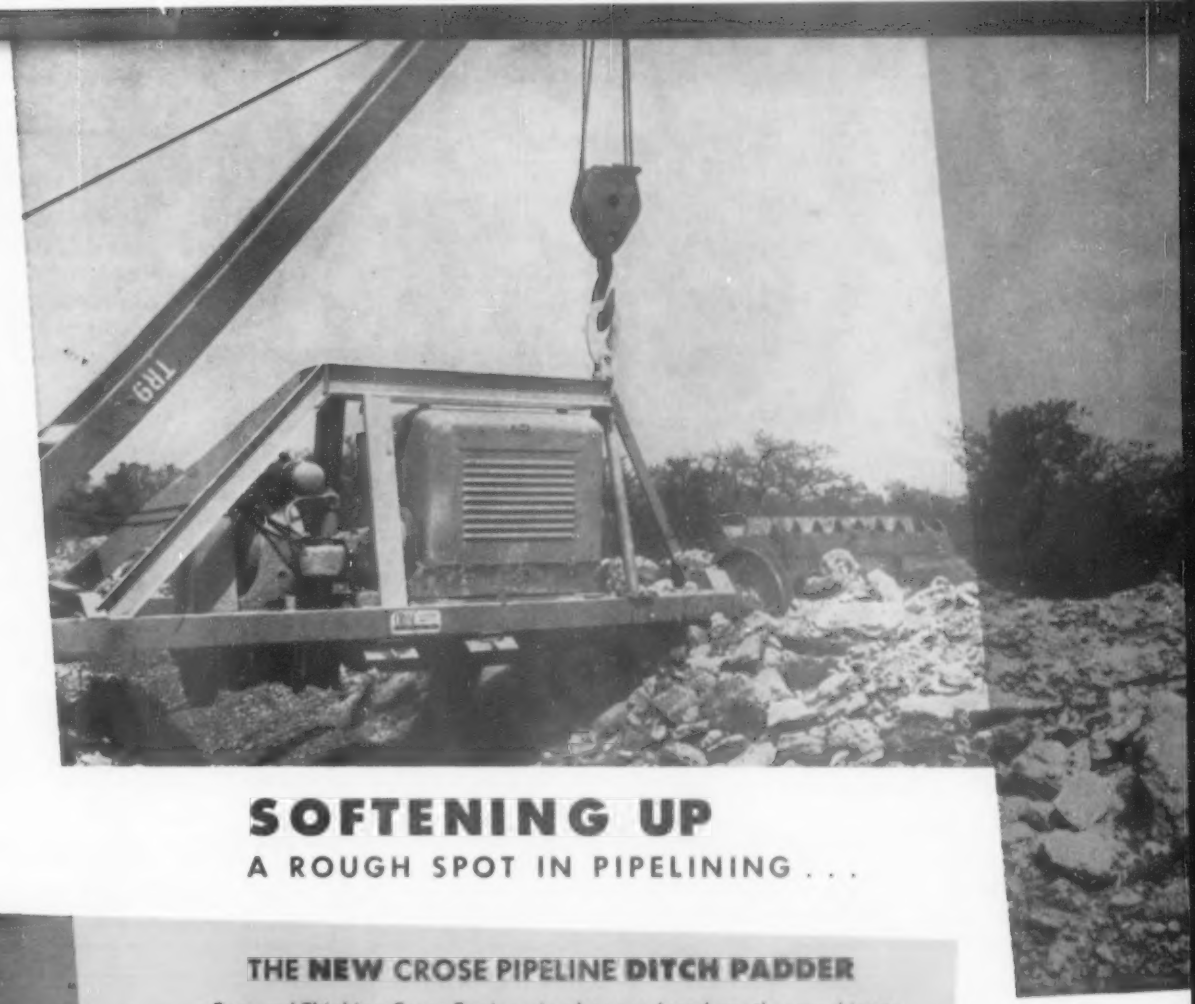
The United States Defense Department.—Sponsoring 485 miles of 8, 10, 12-in. from Cadiz to Zaragoza, Spain. Contracts let to Merritt Chapman & Scott; Benson & Montin of Oklahoma City; Agroman Construction Co. of Spain. Prime contractor is Brown-Raymond-Walsh.

Yacimientos Petroliferos Fiscales Bolivianos (Y.P.F.B.)—Williams Brothers Co. has 190 miles of 4-in. from Camiri to Santa Cruz, to be completed December 1956.

Foreign Natural-Gas Pipelines

• **Alberta Gas Trunk Line Co.**—Plans 547 miles of gathering system for the Trans-Canada line. About 40 miles of 34-in. will be laid in 1956 to connect Bindloss field. Remainder to be laid in 1957 and 1958. Fields to be connected are Pincher Junction, Provost, Sibbald, Oyen, Sunnynook, Steveville, Cessford, Countess, Dutchess, Princess, Homeglenn, Rimbey, Nevis.

Cia. Shell de Venezuela.—Plans 177 miles



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Pipeline Patrol

of 20-in. from La Paz field in the Maracaibo district, to the Cardon refinery on Paraguana Peninsula, to fuel refinery furnaces. To be completed in 1957.

• **Estrada de Ferro Santos a Jundial Departamento Oleoducto.**—Plans 16 miles of 6-in. from Cubatao refinery to Elcloro plant, to be completed December 1956.

• **Gas Industrial de Monterrey.**—Plans 130 miles of 22-in. to parallel a 14-in. line from Reynosa to Monterrey in northern Mexico.

Imperial Oil, Ltd.—Has let 65 miles of 4 to 16-in. gathering system in Redwater area of Alta., to Majestic Contractors, Ltd.

• **Magna Pipeline Co.**—Plans to complete fall 1956, an underwater line from Anacortes or Bellingham, Wash., to Victoria.

North Canadian Oils, Ltd.—Dutton-Williams Brothers, Ltd., has 136 miles of 10-in. from Lake Wabumun to Hinton, Alta., to be completed August 1956, L. A. Stewart, spread man, office at Onoway, Alta.

PEMEX—Plans starting July 1956, on 22-in. line between Reynosa and Monterrey.

Saskatchewan Power Corporation.—Fulton Banister, Ltd., has finished work on 34 miles of 8-in. and 53 miles of 6-in. from Bigger to North Battleford. Job is 50 per cent complete on 120-mile, 12-in. line from Success to Moose Jaw, Sask. Field office is at Swift Current; general superintendent, Jerry Nash; construction superintendent, Tobe Veach.

South Alberta Pipe Line, Ltd.—Filed permit for 150 miles of 8-in. from Etzikom field to serve a nitrochemical plant to be built near Medicine Hat, Alta.

Sui Gas Transmission Co.—Pakistan Constructors, a joint company of Morrison-Knudsen of Boise, Ida., and William Press, Ltd., of London, have 188 miles of 16-in. from Sui gas field to Moultan, Pakistan. Work begins mid-1956. Line to be extended later to Lahore with branches at Kot Addu, Jhang, Magiana, and Montgomery.

• **Technical Office of Hydrocarbon, Ministry of Mines and Petroleum, Government of Venezuela.**—Proposes a 321-km., 26-in. line from Anaco to La Mariposa near Caracas.

• **Trans-Canada Pipe Lines, Ltd.**—Work begins July 1, 1956, on 574 miles of 34-in. from the Alberta-Saskatchewan border to Winnipeg. Contracts let on first four sections to: Majestic Contractors, Ltd.; Canadian Bechtel, Ltd.; Mannix Ltd.; Dutton-Williams Brothers, Ltd. Three sections still to be let. Completion of this stretch planned for December 1, 1956. This is the first stretch of a 2,250-mile line from Alberta to Toronto and Montreal. Deadline for exporting gas from Alberta is December 31, 1957. Tennessee Gas Transmission Co. has proposed a line to take the gas at Emerson, Man. (See Midwestern Gas Transmission Co.).

Union of Soviet Socialist Republic.—Has completed 200 miles (between Stavropol and Rostov) of a 900-mile, 26-in. line from Stavropol in the Northern Caucasus to Moscow. The line, larger than Russia's other two major gas lines which are only 16 and 18-in., will serve Voroshilovgrad, Voronezh, Tula, Yelets, and Serpukhov.

Westcoast Transmission Co., Ltd.—Has let 650 miles of 30-in. from Peace River area, Canada, to Sumas, Wash. Dutton-Williams Brothers, Ltd., has 120 miles from Taylor, B. C., to Azouzetta Lake, to be completed September 1957, O. Graves, spread man, office at Dawson Creek, B. C.

Mannix, Ltd., has 110 miles between Huntingdon and Merritt, Fred Byers, superintendent, office at Chilliwack.

Canadian Bechtel, Ltd., construction division, has 210 miles from Alexandria to Pine Pass, B. C. to complete September 15, 1957, H. F. (Hank) Mogg, spread man, office at Quesnel, B. C.

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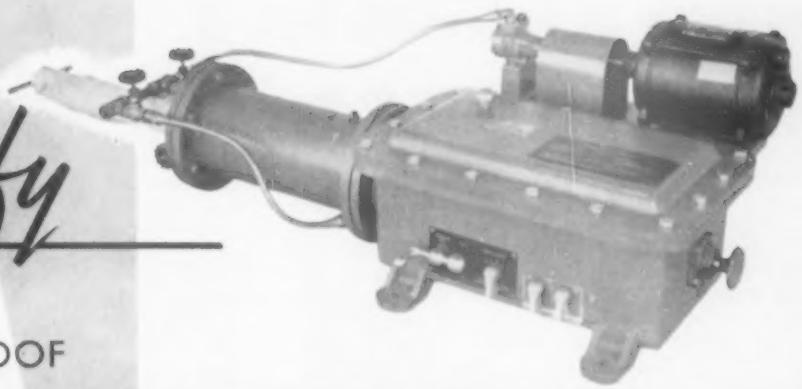

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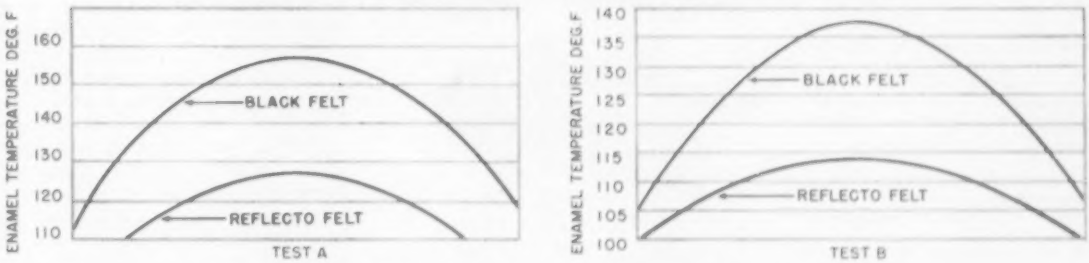

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Research at Columbia Gas Is On a "Round Robin" Basis

by Robert B. Smith

THE gas industry has a large stake in research as a means of providing constant improvement of service to its customers.

The Columbia Gas System believes in the importance of research and relies on it to solve many types of problems.

Columbia Gas System, Inc., is comprised of a service company, 13 operating gas companies, and an oil company. The service company furnishes engineering, accounting, and other services to the various operating companies in the system. Engineering and research services are performed by an engineering and research department in New York City, and a gas-engineering department, in Columbus, Ohio, comprised of approximately 30 engineers who work more directly with on-the-job engineering problems.

In the Columbia organization, many research problems and solutions develop in a sort of "round robin," starting and ending where research results count most—in the field.

Within Columbia's framework, a number of committees operate to coordinate the various functions and activities within the system.

Those projects which provide data or information which would result in improved company operations are recommended to management for action by the appropriate committee. If the recommendations are approved, they are added to the System Manual of Approved Procedures and become required operating procedures.

As an example of how this round robin works, let's take one case. For some time the destructive methods of weld inspection had proved wasteful and time-consuming — especially on those pipeline-construction jobs that raced against time and the seasonal advent of the winter load.

In 1952 the system transmission committee asked one of its subcommittees, the welding and piping-design working group, to study nondestructive methods in conjunction with the gas engineering department. The job was to develop specifications for nondestructive weld inspection that speed up and add efficiency to this vital step in pipeline construction.

The gas engineering department and the working group proceeded to research the various radiographic techniques of weld inspection and made a recommendation to the transmission committee. The recommendation was tentatively approved and put into practice. But the research did not stop there. In 1955 more detailed specifications were developed. Based on this additional research and the requirements of A.S.A. B31.1.8-1955, the new specifications spelled out in detail the requirements as to radiographic technique, quality, film, film processing, general requirements and acceptability. In addition it broke down these requirements and specifications as they applied to widely differing types of construction locations.

The recommendation was submitted to the committee, approved by it and by management, and is now an ap-

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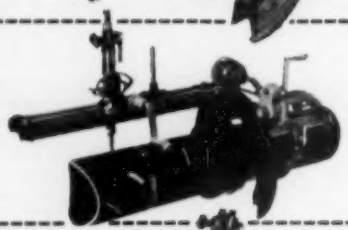

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proved procedure in all Columbia Gas System companies.

Many readers have doubtless been asked for a definition of research or to distinguish between research and engineering. Columbia generally divides research into fundamental and applied. Fundamental research seeks to fill in gaps in existing information or to develop physical or chemical constants for engineering formulas, that is, looking for solutions to new problems. Applied research includes that work which seeks a definite improvement in known processes, procedures, methods, appliances, equipment, etc.

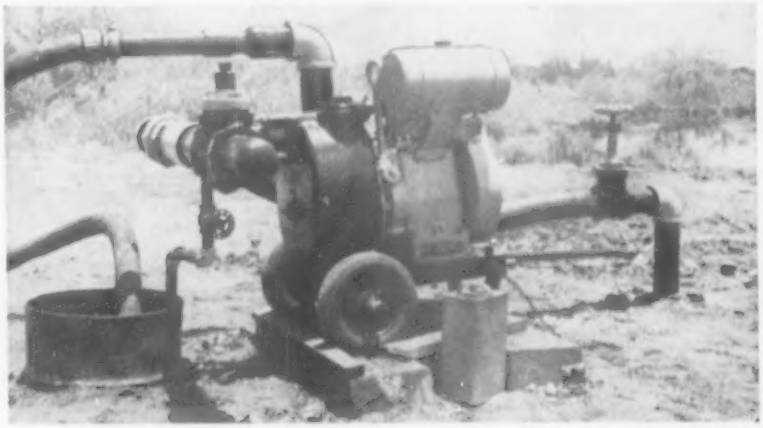
Engineering research, as differentiated from accounting or economic research, is approached as three separate and distinct classifications in Columbia. First are those projects which are carried out within the company by company personnel. The second includes projects performed solely for Columbia by outside research organizations, and the third is comprised of projects undertaken on a national scale, as through the PAR Plan of the American Gas Association.

Considering the first classification, Columbia now has 45 research projects of varying degrees of importance under way.

1. Cause of objectionable noise from gas regulators and development of methods of eliminating it.
2. Effect of soil friction on the restraint of buried pipelines.
3. Hydrostatic testing of pipelines.
4. Internal cleaning and coating of pipe.
5. Welding procedure to eliminate the cindering or excessive slagging of Bessemer steel when welded by the oxyacetylene process.
6. Nondestructive methods of weld inspection.
7. An investigation of the occurrence of porosity in oxyacetylene welded points and determination of methods to eliminate this porosity.
8. Humidifying the air used for combustion in Junkers calorimeters.
9. An investigation of mercuryless orifice-meter differential gages to determine their characteristics and applicability.
10. Better methods of locating and pin-pointing sources of leakage in underground piping, particularly for areas where the gas lines are under hard-surfaced streets.
11. Evaluation of various types of gas-fueled air-conditioning units.
12. Future trends and outlook in total national energy requirements as to the expected role of fossil fuels.
13. Market research including sample surveys of residential customers to obtain appliance saturation and consumption data.
14. Relative merits of inside versus outside residential meter settings.
15. Methods for gathering and assembling data for use in the operation of McIlroy pipeline network analyzer.
16. A statistical analysis of weather data for use in operation and planning.
17. Improved methods for prevention of hydrates in pipelines, particularly with respect to storage pools.
18. Application of the M.I.T. type of high-speed gas-engine indicator to compressor station operating and design problems.

THE AUTHOR

Robert B. Smith was graduated from Ohio State University in 1948 with a degree in mechanical engineering. Following graduation, he joined the Columbia Gas System Service Corp. in Columbus, as a junior engineer. After working in various phases of the company's operations, he was transferred to the New York office in 1951 where he is now coordinator of research, concerned with the various aspects of engineering research as well as the system's program of market research.



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REFINERY MAINTENANCE . . .

Do-It-Yourself, or Contract It?

The author says—

As a general guide, we believe that most refineries should have their own employes handle much of the routine maintenance, the housekeeping, and some of the running maintenance. On the other hand, specialized maintenance work should generally be done by contractors. Whether to contract some shutdown maintenance and some running maintenance depends largely on local conditions at the refinery.

by Henry P. Evans

MAINTENANCE contracted by refineries varies widely. In a single refinery, it may often vary from year to year. Refineries all of the same company may differ greatly on what maintenance they do by contract. Refineries located close to each other may be miles apart on maintenance by contract.

Shutdowns

A few refineries employ a contractor to do all the turnaround maintenance on a process unit. Briefly, their procedure is as follows. Some weeks in advance of the shutdown, the refinery gives the contractor a detailed work list. At the scheduled date, refinery men shut down the unit. Meanwhile, the contractor moves in equipment, superintendent, foremen, craftsmen.

The equipment brought in usually includes large cranes, large mobile compressors, additional welding machines, and air tuggers. As the contractor unbuttons equipment, the refinery inspects. This inspection usually changes the work list. When the work is complete, refinery men start up the unit. The contractor collects costs plus a fee.

Some refineries handle turnaround maintenance entirely with their own men. To do so, these refineries have carefully sized and proportioned the crafts in their maintenance force. They schedule all major shutdowns well in advance. During turnarounds, they postpone some maintenance work and thus build up a backlog. Between turnarounds, they take on enough new construction to keep the maintenance force busy.

Other refineries, perhaps a majority of them, follow neither of these routes. When faced with the shutdown of a large unit, they simply add men as needed to the regular maintenance force. Sometimes the men they add are temporary refinery employes. At other refineries, any additional men needed are hired from one or several contractors. Usually these contractors are asked to furnish men only. The refinery furnishes all supervision and all construction equipment.

Seasonal work . . . At some refineries, large fluctuations in work load come from certain maintenance that is highly seasonal. A good example of this is the painting of outdoor equipment such as tankage, steei structures, fractionating columns. Other work of this type is the major replacement of insulation, grass cutting, etc.

In some sections of the country, such work can best be done by concentrating on it in the good-weather months. Some refineries contract this seasonal work rather than have their maintenance crew struggle with it through the bad-weather months. On such work, they can pretty well define the scope of the work, prepare work specifications, supply the materials, and set the completion date.

In the very same sections of the country, however, you can find refineries that do not contract any of this seasonal work. They reason that this work does not call for special equipment, considerable know-how, or highly trained craftsmen. Thus these refineries have their own maintenance crew handle such work by temporarily shifting men from one craft to another, by taking on temporary employes, or by extending the work over into the bad-weather months.

Special maintenance . . . Certain maintenance calls for specialized know-how, special equipment, or both. Some examples of this special maintenance are as follows:

1. Heavy or difficult rigging.
2. Chemical cleaning of equipment.
3. Certain boilermaker work.
4. Certain types of welding.
5. Major repairs to marine structures.
6. Road maintenance and repair.
7. Certain building-repair jobs.

The equipment needed for this special maintenance work could be bought or rented by a refinery. But most of this work is infrequent in nature. And most refineries find it more economical to employ the know-how and the equipment of a contractor who is continually doing such work. It's important to remember that this special work will often include both capital-account work and maintenance work.

For example, during the last 10 years, we at C F Braun & Co., have done many jobs that we, as engineers-constructors, speak of as repair jobs. These jobs have taken us 2 to 5 weeks in the field, with crews of anywhere from 50 to 300 men. From the refinery viewpoint, these jobs include some new construction as well as maintenance. For example, as part of these jobs we have put cyclones in a reactor, or added trays to a fractionator, added a compressor, or added a blower.

Shopwork

If there's anything consistently uniform about refineries, it's their ability to quickly outgrow their shops. Refineries will double their size without adding space or tools to the shops.

It's not the least bit unusual to find a large refinery, a fairly modern one at that, with very little shop space and few machine tools. Often too, the machine tools are small in size and old in years.

Thus many refineries are forced to send out a lot of ordinary, everyday shopwork. The work sent out includes not-too-difficult jobs in the following categories:

1. Valve work.
2. Cutting of keyways.

The author is with C F Braun & Co., Alhambra, Calif. Paper presented at Rocky Mountain Oil and Gas Association meeting, Salt Lake City, 1956.

3. Balancing of shafts.
4. Fabrication of small pipespools.
5. Metallizing and grinding.
6. Reboring of pump ends, liners, and the like.
7. Repair of tools.

Sometimes this shopwork is done for a fixed price. But more often, the work is charged for on a time-and-material basis. The bill from the outside shop reflects but part of the cost. The refinery does the trucking, checking, and the paper work involved. The cost of these is usually buried in some catch-all account.

Some refineries, but comparatively few, limit the work sent out to special shopwork. That is, they limit it to shopwork calling for unusual skills, large or special machines, or fast completion. Special shopwork is usually work such as:

1. Rewinding of electric motors.
2. General work on heat exchangers, such as the complete retubing of a bundle.
3. Certain work on instruments.

For example, our shops at Alhambra, Calif., will handle several maintenance jobs each month for various West Coast refineries. Most of our work will be bundle retubing. Sometimes our shops will replace nozzles, repair the shell, repair the channel, or do similar work. Often, these jobs are rush jobs. The cost of the work may range from as little as $300 to something over $6,000 when several exchangers are involved.

From this we see that maintenance by contract can take in a very broad field of work. It can call for the use of almost every known craft, including sheet-metal workers, lead burners, and so on. At a refinery, contract maintenance may take in either all or only part of shutdown maintenance, seasonal work, special maintenance, and shopwork.

Why Maintenance by Contract?

When a refinery management is asked: Why do you do this or that maintenance by contract? the answer is almost always the same. The answer is: To cut down costs. This cost reduction conceivably comes from several places. Fewer permanent employes. Less capital invested in maintenance facilities. Units going back on stream earlier

However, when refiners are asked: What are the labor costs to maintain your refinery? they invariably get out the accounting records. If the accounting is typical, some strange things come to light.

Sometimes maintenance men permanently assigned to operating department are being charged against operations. Or warehousemen are being charged to purchasing or accounting

HOW TWO PLANTS, SIMILAR AND NEIGHBORS, HANDLE THEIR MAINTENANCE

1. "CONTRACT" REFINERY

For 7 years this plant has used maintenance labor supplied mostly by contractors' force—370-760 men.

Refinery's own force is constant at 200 men. These include all crafts except bricklayers. Five contractors supply all additional men needed.

Contractors have practically no facilities in plant, and supply little or no equipment. Refinery defines the work and supplies general supervision.

Contractors have about 200 men working in refinery almost the year around. Refinery keeps no backlog of maintenance and does no new construction work with its maintenance force.

2. "YOURSELF" REFINERY

Ten years ago maintenance supervisors estimated 480 men were needed to handle peak load. To level out work load, maintenance backlog is kept and maintenance force does about 15 per cent of new construction. Shutdowns are scheduled well in advance. Practically no maintenance is contracted. Plant believes it gets good payout from high employe morale—steady employment, job security, and promotion opportunities.

COST COMPARISON

Each refinery estimates it spends about 8,000 man-hours per million dollars of plant. Roughly maintenance costs appear to be and may actually be just about the same.

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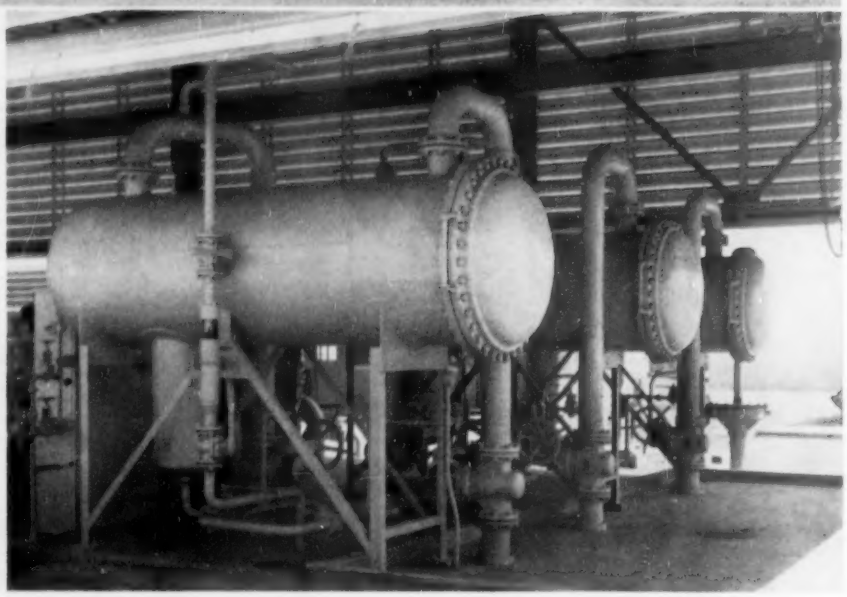

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but not to maintenance. Or contract maintenance is being charged to some catch-all account, or to a material account. How then, can refiners say they are cutting costs by contracting certain maintenance, when really they are not sure what their maintenance costs are?

Perhaps they mean to say they contract certain maintenance because their maintenance department isn't too well equipped for its work. Their costs are sure to be high, they say.

Look for yourself. See those machinists trying to do precise work using old worn-out lathes. Look at those men tearing down pumps and making pipespools out there on the ground—with practically no tools at all. See those pipefitters standing in line at the warehouse to get a few nipples. Watch that warehouseman spend hours hunting through seven or eight old warehouses to find a vital spare part. Look at all that money going down the drain on handling by manpower instead of mechanical power.

Really, then, it's more a question of tooling. For years and years, many refineries have shunned spending capital dollars on facilities for maintenance. That's why their shops don't have up-to-date tools such as automatic welding machines, powered positioners for welding, jib cranes, and bridge cranes.

That's why there are few or no forklifts and no modern truck cranes in the mobile fleet. That's why new process units come in without good paved access ways to get at equipment, with narrow roads on only one or two sides of the unit, with no built-in handling on the columns or at elevated exchangers.

Perhaps, then, what some refineries are really saying is that contractors and outside shops are better tooled to handle a lot of their maintenance work. But might it not be that if refinery maintenance men were properly tooled, they could do the work for much less money than outsiders could?

What to Contract

It doesn't appear sound that a refinery should contract every single bit of its maintenance and risk being critically short of maintenance help during a national emergency, a general strike, or a local building boom. And based on experience to date, one can't simply say, contract as much maintenance as possible and reduce your costs. How then, can a refinery decide on what maintenance to do by contract?

First, a refinery should look at the work now sent to outside shops. The question to answer here is: What shopwork is it economical and practicable to send out? From a send-it-out standpoint, a refinery should consider these things:

1. Outside shops available.
2. Qualifications of these shops—their equipment and their men.
3. Caliber of work they do.
4. Fulfillment of completion promises. Costs charged.
5. Distance to outside shops as it affects completion time and trucking costs.

From a do-it-yourself standpoint, a refinery should carefully weigh the following:

1. Volume of the shopwork in question.
2. Frequency of work—is it steady, seasonal, or spotty.
3. Investment required for the proper machine tools.
4. Need for specialists to satisfactorily handle the work.

Generally speaking, this review of shopwork will tell a refinery to send out only specialized shopwork. Specialized work would include such things as:

1. Rewind of electric motors.
2. Extensive work on heat exchangers, such as bundle retubing.
3. Stress relieving of fairly large equipment.
4. Certain work on instruments.

Tooling . . . Once the question of what shopwork to send out is settled, a refinery should concentrate next on the tooling for all remaining maintenance. This tooling is vital for low-cost maintenance, whether maintenance work is to be done by contractor's men, by refinery men, or by both working together.

Shops should be all in one modern industrial building. Each shop should have the right machine tools for its work. Materials for maintenance should be all together in one warehouse. The warehouse should be equipped with good handling facilities. The fleet of mobile equipment should include enough trucks, forklifts, cranes, and the like.

The garage should be equipped to keep the mobile equipment working. When a refinery is so tooled for maintenance, the question of what maintenance to do by contract is not so difficult to answer.

To maintain a degree of self sufficiency, a refinery should certainly use its own employes to do much of the routine maintenance, especially preventive maintenance, housekeeping, and some of the running maintenance. Thus this leaves shutdowns, some running maintenance, and minor new construction still in the undecided area.

Contract recommendations . . . Let's assume that contractors are available for this latter kind of work. They usually are. Then we strongly recommend that contractors do any shutdown or any running maintenance work that calls for special equipment, unusual craft skills, or special know-how. In the average refinery, this would take in such things as:

1. Chemical cleaning.
2. Heavy or difficult rigging.
3. Certain types of boilermaker work.
4. Certain types of welding.
5. Repairing of roads.
6. Building repairs such as roofing, plumbing, electrical.
7. Repairs to marine structures.
8. Repair of complicated electronic instruments.

When such special work is not done by contractors, the refinery-maintenance department has to resort to improvised equipment, to use men not well versed in the work, to do considerable planning. As a result, the work often turns out to be too costly and not too satisfactory.

As to the remainder of the shutdown and running maintenance, the answer as to whether to contract for all of it, some of it, or none of it, depends largely on local conditions at the refinery in question. Each refinery should evaluate its own situation by looking carefully at the following factors:

1. Operating policies as they affect peak maintenance load.
2. Kind of men available—either from contractors or at the gate.
3. Total rate of pay for contractor's men, temporary employes, or permanent employes.
4. Effectiveness and ability of contractor's supervisory staff. Attitudes of unions.

If an evaluation of these factors says that you should be contracting more running and shutdown maintenance, then by all means arrange to do that contracting which will cut your over-all costs.

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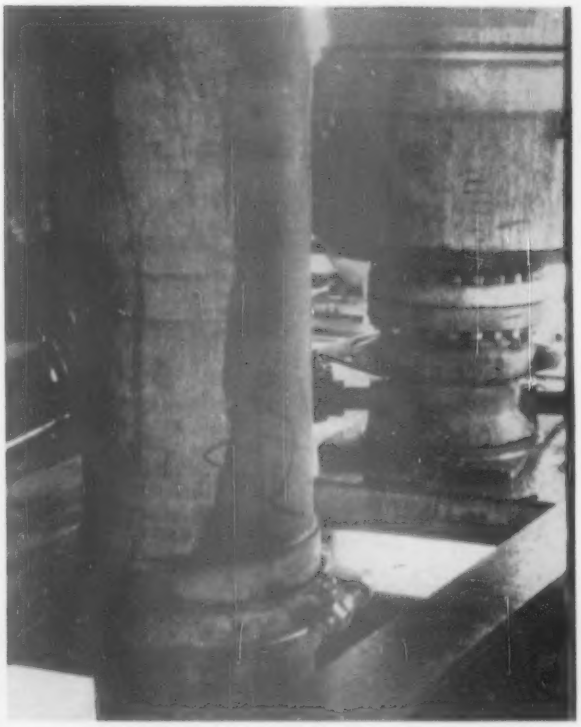
ONLY TWO BOLTS to remove and this blowout preventer is off. And yet the special design of the coupling provides a positive seal and high-pressure rating. Shown are two couplings—a 30-in. connecting the reducer to the drive pipe and a 20-in. connecting the Hydril preventer to the reducer. Many other sizes are available. Fig. 1.



30-IN. NIPPLE takes the place of the blowout preventer on drive pipe after surface hole is drilled. Then the hole is reamed so that 20-in. pipe can be run. Taking the preventer off and attaching the nipple takes only 30 minutes compared to time up to 8 hours to remove and replace bolts of standard flanges. Fig. 2.

Changing Blowout Preventers Take Too Long?

Here's a good way to speed it up

by Ed McGhee
District Editor

TIME is money to any drilling contractor. But, offshore, time is even more costly. The lesson some offshore drillers have learned about saving time in changing blowout preventers can be used by contractors everywhere.

The time saver is a new two-bolt coupling that uses a pressure-energized seal ring. The coupling, called the Grayloc, can replace flange connections that have up to 24 bolts. The Grayloc is patented by Gray Tool Co. and was originally designed for smaller diameters in pressure ratings above 10,000 psi.

However, since the coupling does have only two bolts, its speed in making and breaking soon became apparent. It is this combination of positive seal against high pressure and fast operation that brought it into use with blowout preventers.

Saves up to 8 hours . . . On most offshore wells, surface hole is drilled through a short string of 30-in. drive pipe. Because there is always a danger of blowouts from shallow gas pockets, operators drill the surface hole with a small-diameter pilot bit; the smallest Hydril preventer available, the 20-in., is swaged to the top of the 30-in. drive pipe. Then, if the pilot hole shows no gas, this preventer is pulled, the hole reamed out full size, and 20-in. surface pipe run.

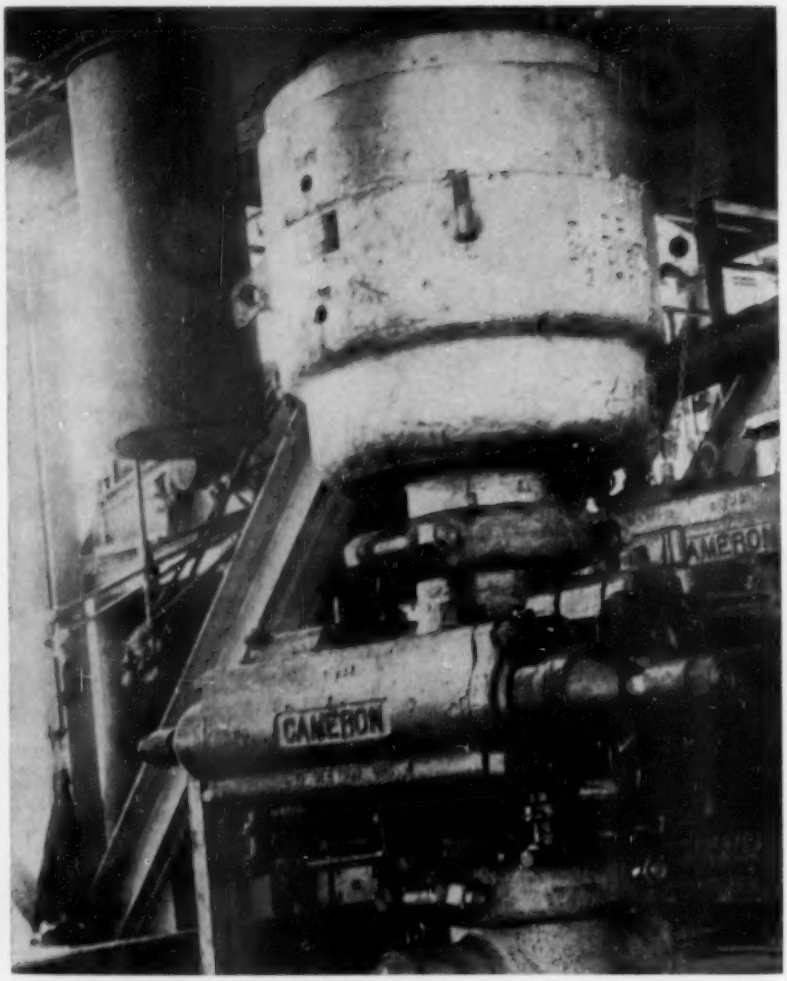
The problem is that removing 24 bolts from the preventer and putting on a flanged pipe nipple atop the 30-in. often takes as long as 8 hours—or more than $2,000 of time on many offshore wells.

DRILLING

The solution to this problem to some contractors has been the hookup shown in Fig. 1. There is one Grayloc connection just below the bottom flange on the Hydril; there is a second just under the 30-in. to 20-in. reducer. It takes only about 30 minutes to break the Grayloc on the 30-in. pipe, remove the preventer, and place the 30-in. pipe nipple as shown in Fig. 2.

As Fig. 3 shows, the Grayloc is not limited to use on Hydril-type preventers; here it is made directly onto the body of Cameron QRC's. These preventers could probably be changed in as little as 15 minutes if necessary.

Keeps pressure confined . . . On the preventers and pipe shown in Figs. 1, 2 and 3, the Graylocs have higher pressure ratings than the A.P.I. ring-type flanged joints they replace. The



PREVENTER HOOKUP with the two-bolt couplings speeds nippling up for drilling after a casing string is set. Here the Hydril is attached to gate-type Cameron preventers. The pressure ratings of these couplings are higher than A.P.I. flange joints. And there's no danger of tightening the coupling too tight and damaging it. Fig. 3.

POSITIVE SEAL action is provided by the seal ring against the bowl of the flange as shown. The slightly different taper of the seal ring forces it to shoulder up under stress allowing no chance for leakage. Fig. 4.

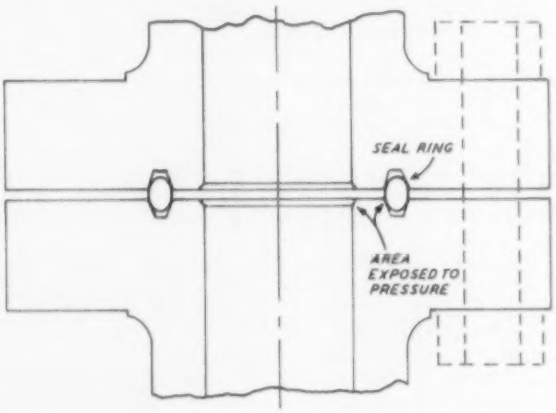
reason for this is shown by Fig. 4. The seal ring on the Grayloc keeps the pressure confined to the inner bore of the connection; thus, there is only a small area on which the pressure may work to force the connection apart. Compare this to the large area on which the pressure acts in the A.P.I. flanged connection shown in Fig. 5.

The lips on the seal ring of the Grayloc have a taper that is 1° different from that on the bowl of the body where they seat. When the connection is made up, this difference in taper forces the lips to deform slightly, thus putting a positive force between them and the bowl. Any internal pressure forces the ring even tighter against the bowl. These two forces between ring and bowl are what give the positive seal against high pressure.

As Fig. 4 shows, when the joint is completely made up, the rib on the seal-ring "shoulders" and prevents any further movement in the connection. For that reason, there's no danger of making the connection too tightly and damaging it.

When the connection is broken, the seal ring returns to its original shape with no permanent set. Therefore, the connection can be made and broken as often as necessary without damage.

COMPARE this A.P.I. flange joint and seal ring with the above pressure-energized seal ring (Fig. 4). Internal pressure tends to force the A.P.I. flanges apart. Pressure against the seal ring in Fig. 4 makes it more tight. Fig. 5.



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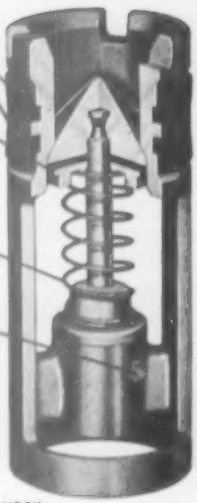

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by W. L. Nelson
Technical Editor

Effect of Charge Stock on Catalytic Cracking

What has been published on yields in catalytic cracking when charging various materials? We are especially interested in viscosity-breaking gas oils. C.P.M.

Although voluminous literature pertaining to this general subject has appeared, there is no comprehensive correlation or organization of such information. Fig. 1 on this page is an attempt to develop such a correlation. It is based primarily on the data of Oden and Perry[2] and it does not check well with the other references. Accordingly, it can only be considered as a general indication of the behavior of different stocks. There are two general kinds of stocks (1) straightrun and certain solvent raffinates, and (2) materials degraded by cracking such as cycle or recycle stocks, viscosity broken and coker gas oils, etc. The solid lines in Fig. 1 are for stocks degraded by cracking whereas the dashed-line extensions apply to straightrun or solvent-treated materials. Extract materials are not included because they are definitely unsuitable for catalytic cracking.

Finally, it must also be stated that materials that are contaminated by large amounts of metallic catalyst poisons, or excessive amounts of nitrogen or sulfur will not behave as indicated in Fig. 1.

It is believed that the curves are reasonably accurate for mildly degraded materials such as viscosity-broken stocks. These would have characterization factors of 11.5-11.8 depending upon the properties of the parent stock.

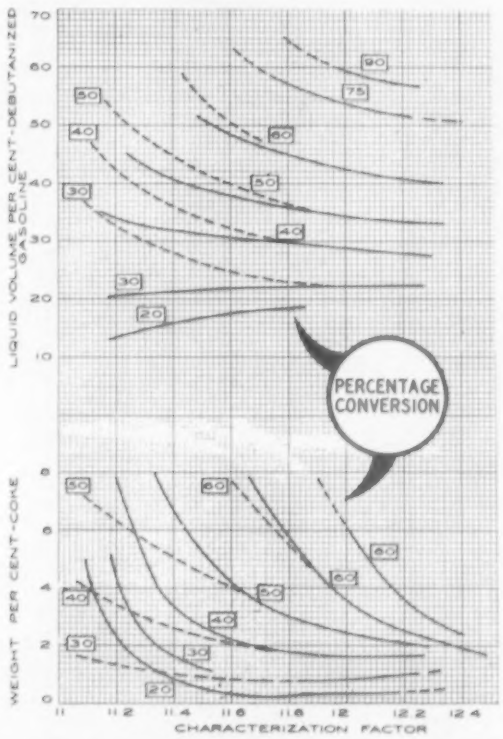

Fig. 1—Approximate effect of type of charge stock on catalytic cracking yields. (Dashed-line extensions are for straightrun materials and solid lines for materials degraded by cracking.)

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Stain Number of Coating Asphalts

What is the stain number of your answer of September 7, 1953? B.R.S.

Although there are many tests pertaining to the staining qualities of asphalt, the standard number is an old method described by Schweyer and Howell, Ind. Eng. Chem., Anal. Ed., 9, 563, Dec. 15, 1937.

One gram of asphalt (to nearest 0.2 g.) is cut from below the surface of the sample and it is made into a flat disk of about 1.5 cm. diameter. It is placed between two pads of paper, each clipped together at the end and each consisting of 16 sheets (10 by 8 cm.). The paper is specified as 4-lb. "Washington" grade (cigaret paper) of Peter J. Schweitzen, Inc., Elizabeth, N. J. Such paper should be 0.015 mm. thick with a densimeter reading (D202-36T) of 800-1,000, it weighs 7 lb. per 2,880 sq. ft., and it must not be too dense or too porous. The pads and disk are placed in an oven at 130° F. (plus or minus 1°) for 1 hour to soften the asphalt. A weight is then placed on the pads and disk for 5 days at 130° F. The weight consists of a 3-oz. gill type ointment box (D5-25) having a base diameter of 5.6 cm., containing enough lead shot to weigh either 50 or 400 g. If the ring and ball softening point is below 170° F., a weight of 50 g. is used, otherwise 400 g. The stain number is the average of the number of sheets above and those below that have been stained. The sheet in contact with the asphalt is counted as No. 1, and duplicate tests should agree within one-half stain number. The test is not satisfactory for asphalts that have suffered decomposition by having been previously overheated.

For 20 penetration asphalts (77° F.) the stain numbers are somewhat as follows:

	Softening point (R&B)	Stain No. 50 g.	Stain No. 400 g.
Steam refined	Below 150° F.	1 or less	
Slightly blown	150°-170° F.	1-2	
Semiblown	170°-190° F.		1-5
Fully blown	190°-210° F.		2-9
Fully blown	Above 210° F.		3 plus

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by Stephen Bencze

Industrial Power Cycles for Oil-Industry Use—8

IN THE noncondensing cycle, no steam goes to a condenser; all of the steam flow through the turbine is used in process. This cycle is not penalized by heat lost to condenser circulating water thus power is produced at the very lowest cost. In fact, the heat required to produce a unit of power approaches the heat equivalent of the unit of power plus a small amount added by electrical or mechanical losses.

Fig. 12 shows the cross-section of a typical single automatic-extraction noncondensing turbine. This unit drives a 2,000 kw. generator at 3,600 r.p.m. with steam at 600 psig. —720° F.T.T.—5 psig. with controlled extraction at 130 psig.

Whenever steam is required in sizable quantities for heating or for processing, electric power usually can be generated more cheaply than it can be purchased. After consideration of all the various types of industrial power cycles, the logical question of which type of cycle to use must be answered.

To arrive at the answer basic analysis and evaluation of reliability and suitability of operation must be made. In addition the basic cost economics involving capital expenditure and operating costs must be evaluated. Each individual application stands on its own because of the many variables of steam conditions, power and process steam demands, and operating peculiarities.

Author is with DeLaval Steam Turbine Co.

To have some basic comparison between the various types of cycles, Fig. 13 has been prepared. These diagrams show the utilization of available heat for the various cycles. The figures shown on the diagrams are based upon the following conditions:

Inlet steam — 400 psig. and 750° F.T.T., exhaust, condensing — 28½-in. vacuum, exhaust, noncondensing — 5 psig., electrical load — 5,000 kw., extraction steam — 50 per cent throttle flow, and extraction pressure — 5 psig.

For 100 per cent heat input to all the cycles shown, the following should be noted:

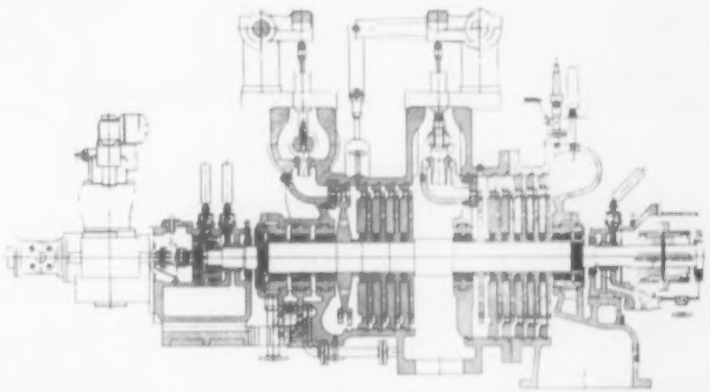
1. For the straight-condensing cycle no steam is available for process and 71.4 per cent of the heat input is rejected to the condenser and 27.1 per cent is realized as useful power.

2. For the uncontrolled extraction-condensing cycle again no steam is available for process but only 69.0 per cent of the heat input is rejected to the condenser and 29.5 per cent is realized as useful power.

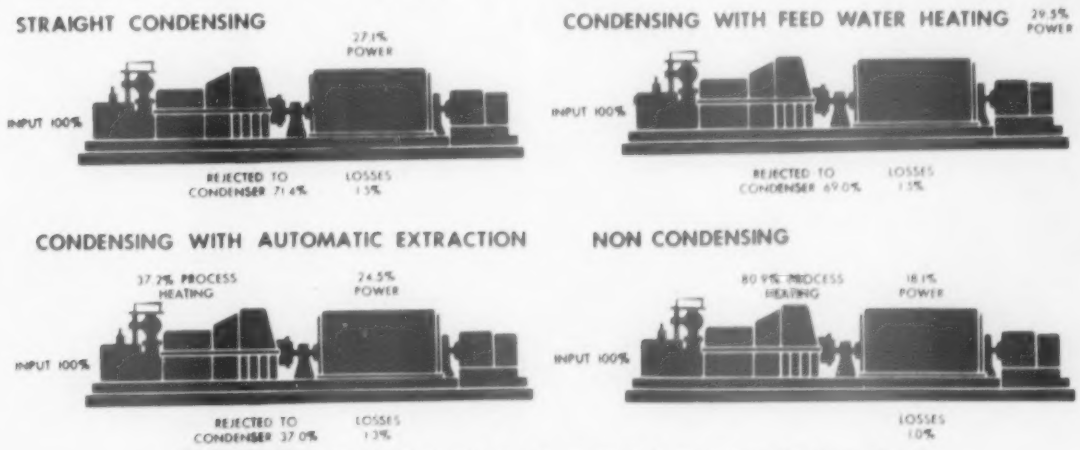
3. Where no process steam is required and only electric power is needed, the uncontrolled extraction-condensing cycle with feedwater heating is the more efficient cycle.

4. In the controlled extraction condensing cycle 37.2 per cent of the available heat goes to process steam, 24.5 per cent goes to power, and only 37 per cent is rejected to the condenser. This cycle adequately and efficiently fulfills the demand for both electric power and process steam.

5. In the noncondensing cycle 80.9 per cent of the available heat goes to process, 18.1 per cent goes to power. This cycle fulfills the demand for large quantities of process steam in relation to the electric-power demand.



CROSS-SECTION of a typical single automatic-extraction noncondensing turbine. Fig. 12.

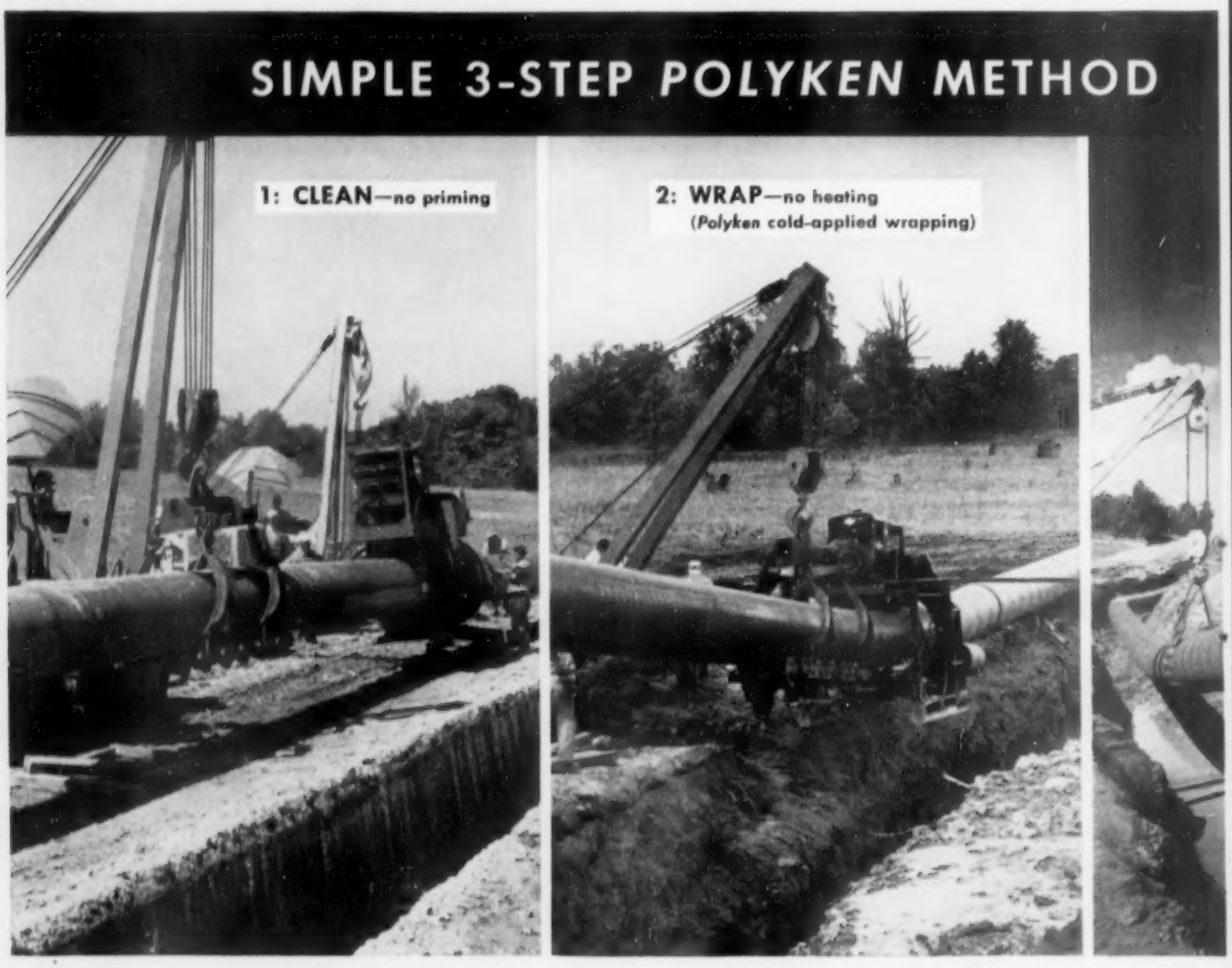


PERFORMANCE COMPARISON of industrial cycles is shown in these drawings. Fig. 13.

THE **MODERN** PIPELINE
PROTECTION MAKES NEWS:

Polyken being used on new 22″ transmission

(122-mile lateral from Defiance, Ohio, to Bridgman,



polyethylene tape American-Louisiana line

Michigan)

10-mile test showed American-Louisiana and Houston Contracting Co. these cost-cutting advantages of *Polyken* tape coating:

1. **Half as many crewmen** needed to do the job.

No labor or equipment to break drums, chop materials, melt and transfer coating—*Polyken* tape is ready to cold-apply right from the roll.

No labor or equipment to handle priming operation—*Polyken* tape is cold-applied directly to clean pipe, with the adhesive acting as its own primer.

No labor or equipment to rehandle pipe or skids after coating or to repair skid marks—*Polyken*-coated pipe goes directly into the ditch.

2. **No drying or cooling time**—pipe can be tape-wrapped right behind the cleaner and lowered right behind the wrapper; trench can be immediately backfilled.

3. **Vastly reduced warehousing, shipping and handling costs**—coverage per pound is increased; far less material is handled per mile of pipe.

4. **No hot dope liabilities** from drum cuts, spills, fumes and burns. No need for protective clothing or masks. *Polyken* taping is simple, clean, safe.

5. **Coating perfection**—simple, 3-step application puts *Polyken* coating into ground in factory-uniform condition.

These five big points in favor of *Polyken* taping, the *modern* pipeline protection, convinced American-Louisiana . . . and confirmed other results already experienced by many in the gas industry. Like to know more? To talk over your project—write, wire or phone *Polyken Sales Division*, 309 W. Jackson Blvd., Chicago 6, Illinois. WEbster 9-7100.

Complete catalog, Sweet's Industrial Construction File, Sec. 6c/Ke

Polyken® CONTROLLED STRENGTH

PROTECTIVE COATINGS

The Kendall Company, Polyken Sales Division

OG-1

Armco Surface Casing... Ready when you need it from these convenient stocking points

When drillers need casing they usually need it in a hurry. Thus, ready availability is one of the important reasons why Armco Surface Casing has received such wide acceptance. Armco Casing is distributed by National Tank Company from 25 stocking points conveniently located throughout the oil country. Chances are one of these stocking points is near you.

An adequate supply of casing is maintained at these stocking points in sizes to meet your immediate needs. In addition, they will promptly handle your order for direct mill shipment.

Armco Casing offers many other advantages to drillers. Long, 40-foot lengths mean fewer sections to handle, fewer joints to assemble. The Armco Slip-Joint and uniformly round cross-section allow quick stabbing and fast, easy alignment. Diameters range from 6 to 24 inches, wall thicknesses from $\frac{3}{16}$- to $\frac{1}{2}$-inch. Write us for complete information. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 4366 Curtis Street, Middletown, Ohio, 201 KOME Building, Tulsa, Oklahoma. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.

1. Swift Current, Canada
2. Williston, North Dakota
3. Casper, Wyoming
4. Sidney, Nebraska
5. Brush, Colorado
6. Great Bend, Kansas
7. Liberal, Kansas
8. Pawhuska, Oklahoma
9. Oklahoma City, Oklahoma
10. Seminole, Oklahoma
11. Hobbs, New Mexico
12. Pampa, Texas
13. Lubbock, Texas
14. Snyder, Texas
15. Abilene, Texas
16. Electra, Texas
17. Odessa, Texas
18. Corpus Christi, Texas
19. Houston, Texas
20. Shreveport, Louisiana
21. Lake Charles, Louisiana
22. New Iberia, Louisiana
23. Harvey, Louisiana
24. Clay City, Illinois
25. New Harmony, Indiana

National Tank Company stocking points for Armco Casing

Armco Slip-Joint Casing

Distributed by National Tank Company, Tulsa, Oklahoma. In Canada: National Tank Company, Ltd.

Among the

Drilling Contractors

Dallas Drilling Firm Adds Contract Representative

Fryer & Hanson Drilling Co., Dallas-headquartering contracting company, is adding a new contract representative. He is R. J. Maberry, of Midland, Tex., where he has resided the past 12 years. He will work primarily in the West Texas and New Mexico area.

R. J. MABERRY

Maberry has been in close contact with the drilling industry for many years through his former association with banks in Dallas and West Texas, and has been directly connected with the oil industry the past 4 years.

Fryer & Hanson rigs are working in West Texas, New Mexico, and on the Gulf Coast.

J & B Drilling Co. has two new contract jobs in Beauregard Parish, southwestern Louisiana. Both are wildcats. One is for Gasoline Production Corp. at 1 Powell, in 13-6s-9w, in the Ragley area, in the southwestern part of the parish. The other is for F. G. Weimer and J. P. Fitzhugh at 1 Lutcher & Moore, in 13-7s-12w, in the southwestern corner of the county. The former is set up for 9,500 ft. and the other for 6,950 ft.

San Jacinto Drilling Co., Houston, is making hole on a new wildcat job in the Long Mott area, 2 miles northeast of Seadrift, in Calhoun County, Texas Gulf Coast. It is a 9,000-ft. test for H. J. Scibienski and J. W. Herndon.

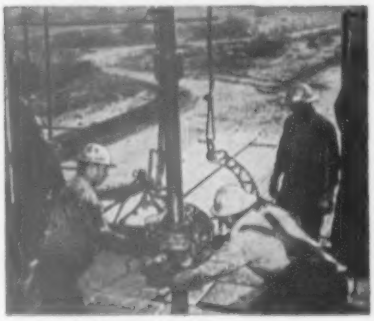
Sharp Drilling Co., Midland, Tex., is on a new deep Devonian contract job in Lea County, New Mexico. It is a projected 13,500-ft. wildcat test for Skelly Oil Co. on its West Tatum Unit, 4 miles west of Tatu. Location is in 26-12-35.

Martin & Stevens, Bakersfield, Calif., are keeping a rig working for Gilliland Oil Co. in the new "hot spot" in the Devils Den area, northwestern Kern County, California. Current operation is 2 Bandini-UC. Gilliland's second well in development of the recently opened Point of Rocks (Eocene) sand.

Longhorn Drilling Corp., Three Rivers, Tex., has contracted to drill a 12,000-ft. wildcat test for Mayfair Minerals, Inc., of McAllen, Tex., on its Shary lease about 4 miles southeast of Mission, Hidalgo County, in Texas' Rio Grande Valley. It also has contract for a 5,500-ft. wildcat test

DRILLING in Grayson County, North Texas—L. A. Wilson (top left), and his sons, H. W. Wilson (at his left) and R. L. Wilson (lower row center), owners of Wilson Drilling & Service Co., Wilson, Okla., with one of their crews on a contract job in Whitesboro field, in the west-central part of the county. Shown, in addition to the Wilsons are: Hopalong Cassidy and Donald Bollies (top row), and Robert Tynes and Bill Bolles (bottom left and right).

bargain thread dope?



Is cheap thread dope really a bargain? Tool joint and drill collar thread wear can cost a lot over a year's time. Fishing jobs come plenty high. Galling or washouts mean hundreds of dollars of extra expense. 'Bestolife Lead Seal stretches thread life, cuts down on fishing jobs, galling and washouts. That's why it's the most widely used lead base thread compound in the world. Get 'Bestolife at your supply store. In 1¼, 5, 20 and 50 lb. cans. Unconditionally guaranteed.

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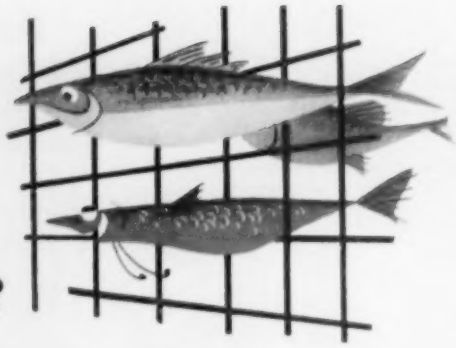
NOW BUYS
MUDWONDER

J. W. "Bill" Hall of Durham Drilling Co. now buys Mudwonder Mudline Valves for zero maintenance.

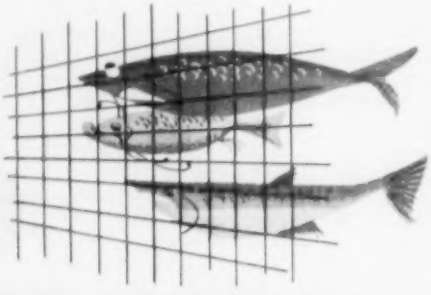
Edward Valves, Inc., Subsidiary of Rockwell Manufacturing Company, East Chicago, Ind.

What good is a net that the fish swim THROUGH?

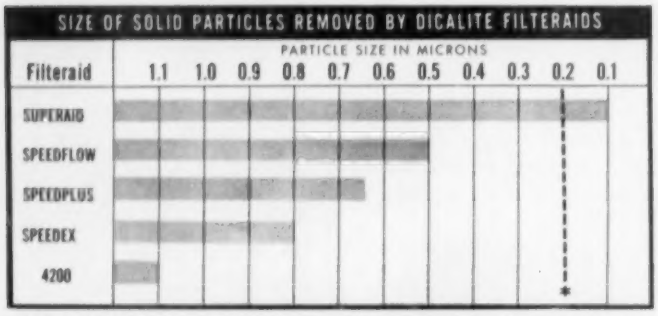


The major difficulty in securing trouble-free flood water is not the larger impurities, easy to precipitate or settle . . . it's the little devils which can slip right through when ordinary separation processes are used. These microscopic hellions . . . algae, bacteria (especially the sulfate-reducing bacteria) and chemical precipitants . . . find happy homes in the pores of the formation, grow there, increase and multiply till the formation is plugged and the water drive practically destroyed.

But they can't get through DICALITE!



SIZE OF SOLID PARTICLES REMOVED BY DICALITE FILTERAIDS



*0.2 MICRON – Theoretical limit of resolution of optical microscope. Few microscopes achieve it.
80.0 MICRONS – Smallest particle size visible to the unaided eye at 10" distance.

That's why many of the diatomite filter systems now operating on water flood projects use Dicalite Filteraids. As the chart shows, there's a Dicalite grade to filter out unwanted particulates of any size – algae, bacteria, colloidal solids – even down in the submicron range. Simple tests made by Dicalite service engineers can quickly indicate the grade and amount required for any desired clarity at optimum flow-rate.

Diatomite filter systems for water flood projects occupy only 1/5th the space of a sand system, and can be completely unitized. Capital investment is usually lower, too. So, if pump pressures are steadily rising and the water drive is slowing, investigate the many advantages of Dicalite in a diatomite filter system. Write for full information.

Dependable GLC GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

DICALITE DIVISION
Great Lakes Carbon Corp.
612 So. Flower St.
Los Angeles 17, Calif.

for Finley Co., of Reno, Nev., at 1 Alfredo Spillman, in Duval County, South Texas.

Conway-Tanner Drilling Co. has a new contract operation 8 miles northeast of Winnsboro, Wood County, East Texas. It is for B. B. Orr at 1 D. W. Crumpler estate et al, in the W. Jacobs Survey. Contract objective is 8,500 ft.

Miller & York, Bakersfield, have a rig working for Amerada Petroleum Corp. in the Pixler area, Tulare County, Central California. It is a 4,000-ft. test at 76-29, in 29-22-26. It is a wildcat.

Del Mar Drilling Co., Corpus Christi, Tex., has the contract on a new deep (9,500-ft.) test King & Heyne 1st Oil Co., of Houston, is starting at 1 Gabriel, in the CG&SF Survey 317, 3 miles southwest of Clarkwood, west of Corpus Christi, in Nueces County, lower Texas Gulf Coast.

Loffland Brothers Co., Tulsa, has the contract on a 14,000-ft. test Continental Oil Co. is undertaking 3 miles south of production at White Lake in the coastal marshes of Vermilion Parish, southwestern Louisiana. Location is on a Louisiana Furs, Inc., lease, in 28-15s-1e.

Pernie Bailey Drilling Co., Houston, is scheduled for a 9,600-ft. wildcat test to be drilled for Cyprus Oil Co. 3 miles southeast of Opelousas, in southern St. Landry Parish, South Louisiana. The test is at 1 Robin, in 29-6s-5e.

Thomas Drilling Co. is contractor on a new wildcat test Garland Smith is starting 4 miles northeast of Maljamar, in western Lea County, southeastern New Mexico. Location is listed as 1 Gulf-State, in 29-16-33. It is north of the Roberts area. Contract is for 5,500 ft.

Crawford Drilling Co., Shreveport, has contracted for a 10,500-ft. wildcat test to be drilled for The Texas Co. in northern Lafourche Parish, Coastal Louisiana. Its location is on the east side of Lake Boeuf, north of Raceland and about 20 miles southwest of New Orleans. It is on State Lease 2374, in Township 15s-18e.

Guy Mabee Drilling Co., Midland, Tex., has a new deep wildcat operation 10 miles southeast of Lovington, in eastern Lea County, southeastern New Mexico. It is a contract job for Cities Service Oil Co. at 1 "AZ" State, in 32-16-38. Location is southwest of the Garrett area and west of Knowles field. It is a 13,000-ft. Devonian test.

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AND PROVEN
IN THE OIL FIELDS

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BALL BEARING MOTORS

- VERMIN PROOF
- DRIP PROOF
- CORROSION RESISTANT
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Yes . . . all these features are combined in Fieldmaster Ball Bearing Motors to make them the leading power units in the oil country. Naturally there's a type and H.P. especially suited to fit your specific requirements.

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WHEELING MACHINE PRODUCTS CO.
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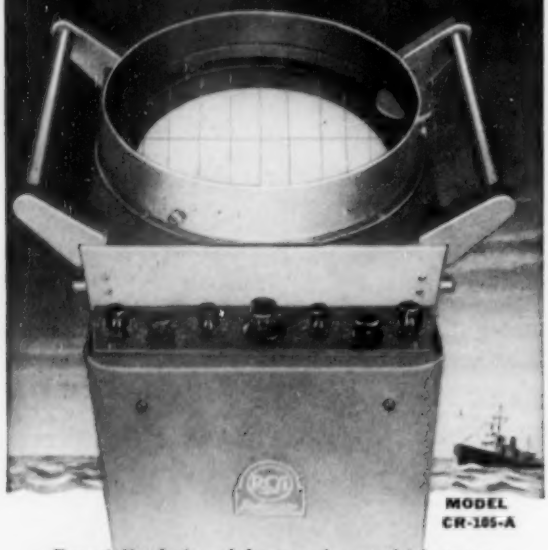
New Radiomarine Small Boat Radar

- Saves Money
- Saves Space
- Saves Power



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Especially designed for vessels on which space and power are limited, Radiomarine's new CR-105-A Radar offers you the EXTRA features that give you MAXIMUM PERFORMANCE—MAXIMUM CONVENIENCE—MINIMUM MAINTENANCE. Only two basic units—indicator and antenna. Indicator is in deck mounted binnacle . . . keeps picture tube high for best viewing . . . requires less than two square feet of deck space. Antenna is lightweight . . . only 105 pounds. Instant selection of 1-2-4-12-32 mile ranges helps you navigate through foul weather and traffic hazards to cut your trip-time, boost your profits. You'll read the clear, bright pictures on its 10-inch scope easier . . . service it quicker with the easy-access chassis. And here's another saving . . . the Radiomarine CR-105-A requires only 600 watts from ship's battery or other D.C. power supply. Find out more about the new Radiomarine CR-105-A . . . it can mean greater profits for you right now.

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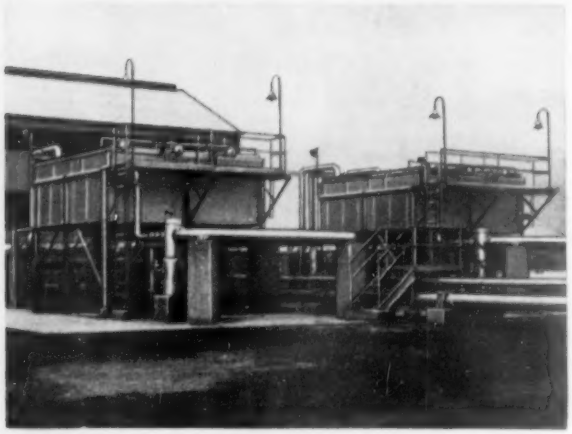
Young Engineering Talent

Shows Results in Actual Use at Illinois Gas Storage Field



Young "H-C" UNITS . . .

cool natural gas for underground storage

Hundreds of feet below Herscher, Illinois, lies a geological dome used to store natural gas for Chicago and 24 other gas utility companies in a six-state area. Before gas from the pipelines can be injected into the underground reservoir, it is cooled by two Young "H-C" units to eliminate the danger of cracking or warping the well cementing and disturbing the underground formation. Young "H-C" horizontal core units combine the *efficiency* of vertical air discharge, the *economy* of compact design, and the *versatility* of multiple unit combinations.

More Young "H-C" Units used in desulphurization of vent gas

Also in operation at Herscher is a vent gas gathering system which gathers, desulphurs and re-injects into the reservoir escaping gas. Here, too, Young "H-C" Units cool the gas to the proper degree before it is re-injected.

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Put Young Talent to work for you . . .

Solving heat transfer problems is what we do best because it is our very reason for being. You, too, can harness the power of Young engineering talent. Write, wire or call without obligation.

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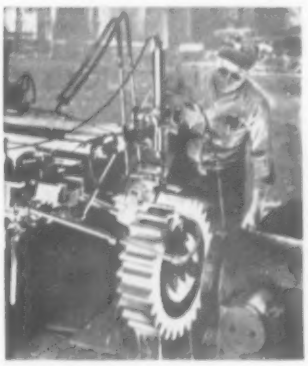
Eleven 22-B's help beat time, terrain, low temperatures on Canadian gas line

Majestic Contractors Ltd., a fast-growing, fast-moving Canadian construction company, recently completed a 226-mile pipeline from the gas fields near Coleville to Prince Albert in Saskatchewan. It was finished on time despite difficult terrain, tough river crossings, and sub-zero temperatures.

Eight of the eleven Bucyrus-Erie 22-B excavators working on the spread were assigned to the toughest trenching jobs. On the St. Louis crossing of the North Saskatchewan River, large boulders — too large to be handled by the suction dredge preparing the river ditch—were encountered in the path of the trench. Two 22-B's — a dragshovel and a clamshell — were positioned on a barge to do the boulder digging. On land, too, some sections of the line were underlaid with boulders of all sizes. These sections, and also road and railway approaches, were handled by four 22-B dragshovels and two 22-B clamshells.

This kind of performance from Bucyrus-Eries is typical on pipeline spreads. You get dependable on-the-job performance because Bucyrus-Erie designs and builds for quality every step of the way. For your next pipeline job, put Bucyrus-Eries to work helping keep costs down, jobs moving on schedule. Your nearby distributor has all the facts.

236E56



Bonus Quality Bucyrus-Erie starts with highest quality steel, then carefully flame hardens it like this to bring you gears and pinions that wear longer, keep maintenance costs low.

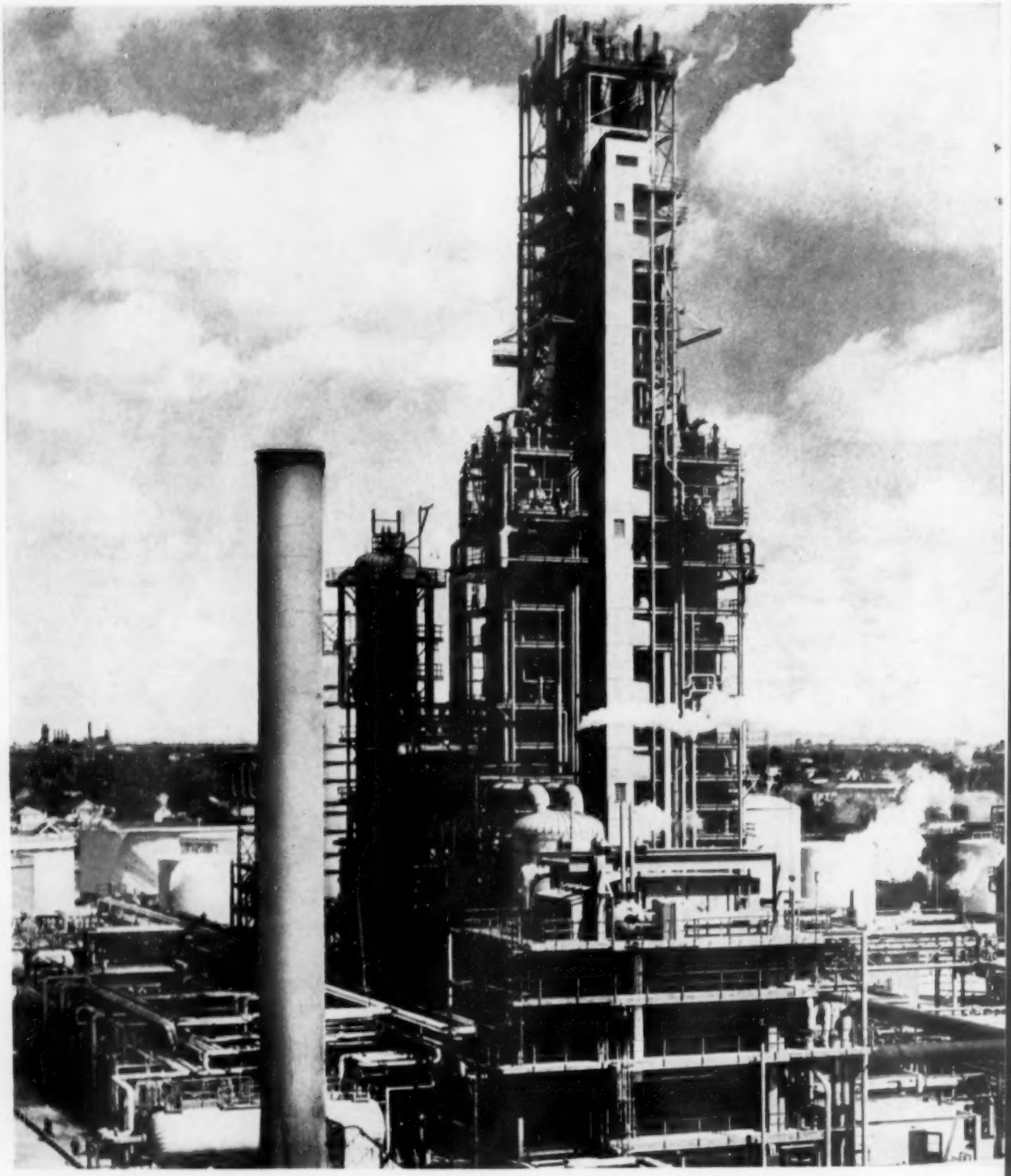
BUCYRUS ERIE

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN

Refinery Operating Records Prove...

Fuel Costs Go Down When



A B&W CO Boiler Goes In

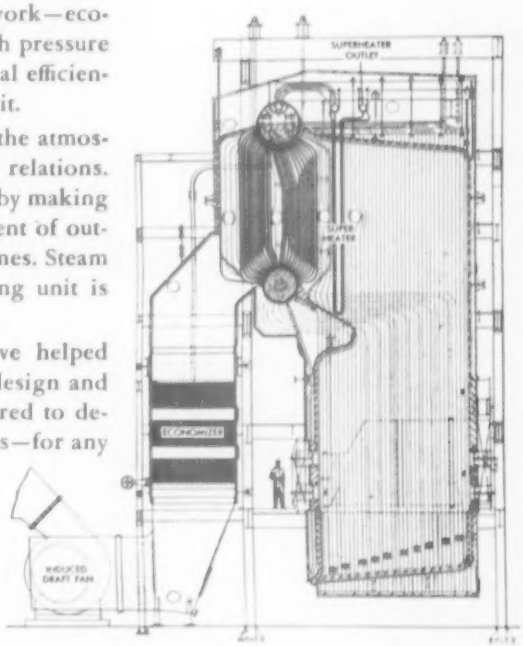
Savings Can Be Calculated in Thousands of Dollars... Atmosphere is Kept Clean

Designed and developed to raise refinery thermal efficiency to still higher levels, the B&W CO Boiler has effectively demonstrated its *reliability, efficiency and economy in extended, sustained service.*

FUEL SAVINGS ARE SUBSTANTIAL because sensible and combustible heat content is put to work—economically. Steam can be produced at high pressure and temperature, resulting in high thermal efficiencies for prime movers of the cracking unit.

OTHER ADVANTAGES include keeping the atmosphere clean for improved community relations. Also, the CO Boiler simplifies operation by making your cracking unit completely independent of outside sources of steam and energy at all times. Steam is always available—whether the cracking unit is operating or shut down.

DIFFERING REFINERY CONDITIONS have helped develop CO Boilers that are flexible in design and arrangement. B&W engineers are prepared to design a unit that will meet your exact needs—for any steam pressure or temperature and *any size* cracking unit—large or small. Write for details—The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, New York.



B&W CO Boiler in midwestern refinery delivers 190,000 pounds of steam per hour at 500 psi and 575 F. It saves 44½ million BTU's per hour.

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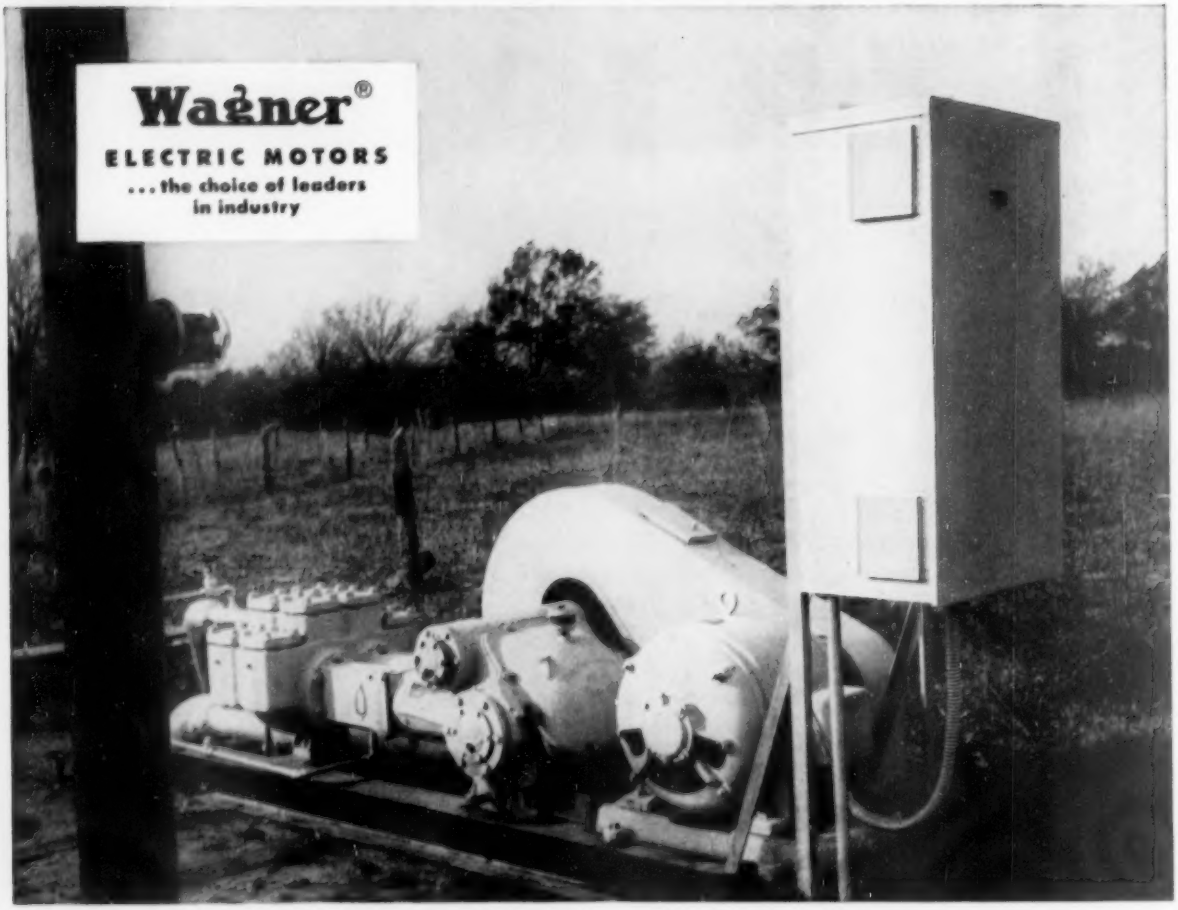
BOILER DIVISION

G-814-CO



portable power for the petroleum industry

American Oil Pipe Line Company pipes crude oil from lease tanks to storage tanks of oil refineries. The network of pipe in a field is called a "gathering system."

At various gathering system locations, you'll find gathering pumps which keep the heavy crude oil coursing through the pipeline. These gathering pumps are put on skids so they can be moved about to give the system greater flexibility. American can move its pumps quickly and easily whenever new pipe is added or old pipe is abandoned.

A 25 horsepower Wagner motor is the hard-working heart of each of these portable pumps. Wagner motors are chosen for this application because they go about their ceaseless job of hurrying crude oil to the refinery with complete dependability and a minimum of maintenance.

Perhaps you have a specialized motor application . . . if so, remember, there's a Wagner motor to fit every need . . . a complete line for all current specifications with a wide variety of enclosure types and mountings.

Your nearby Wagner engineer can help you select the *right* motor to meet your specifications. Call the nearest of our 32 branch offices or write us.

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Clear proof you can prevent plugging caused by iron in injection water!
CITRIC ACID ADDED
In this glass, only 10 ppm of Pfizer Citric Acid has been added to brine containing 2 ppm iron
NO CITRIC ACID
The brine in this glass also contains 2 ppm iron. But no citric has been added

● The cloudiness of the brine at right is caused by insoluble iron salts. Continuous injection of this water in secondary recovery causes plugging at the interface.

As you can see from the picture on the left above, Pfizer Citric Acid keeps the iron in your injection water from precipitating out...and thus piling up deposits at the interface.

Net result: Regular use of Pfizer Citric Acid will keep your injection rates high easily and economically. Also cuts down the frequency of expensive acidizing.

Pound for pound, citric acid sequesters iron better and at less cost than any other agent. High calcium and magnesium waters will not interfere with citric's iron-sequestering ability.

Nontoxic, safe to handle—Pfizer Citric Acid is excellent preventive medicine—whether for secondary recovery or pressure maintenance work. Pfizer supplies huge amounts of citric acid for a multitude of industrial uses throughout the world. This broad distribution pattern assures you of receiving all the citric you need without delay. (Just recently, Pfizer has opened a new warehouse in Dallas to serve the Southwest.)

For further information on preventing injection well plugging with Pfizer Citric Acid write to:

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Steam Trap Standardization Slashes Trapping Costs

Major User Reports $25,000 Annual Maintenance Saving with 4000 Armstrong Traps

Here are the Benefits

- ***Quick Replacement of Traps*** **simply by uncoupling unions and installing a "spare" trap complete with nipples and half unions.**
- ***Bypasses Not Needed*** **—drain line can be shut off during quick trap replacement, even on critical equipment.**
- ***Repair Parts Inventory Reduced*** **by standardization on one make of trap.**
- ***Purchasing Simplified*** **through standardization.**
- ***Maintenance Men Become Experts*** **on one make of trap.**
- ***Armstrong Traps Last Longer*** **with less maintenance.**

MAJOR REDUCTIONS in steam trap installation and maintenance work and cost can be achieved by standardization on one make of trap which, in turn, permits standardized hookups. For example, a major chemical company reports an annual maintenance saving of $25,000 since installing 4000 Armstrong traps according to the drawing and photographs shown here.

Traps of a Size Interchangeable

Note particularly that exact dimensions are given for the pipe fittings, including nipples, connected to each size of trap. When a trap needs repair, the unions can be uncoupled, the trap lifted from the line, and a "spare" carrying indentical length nipples and half-unions slipped in place. Thus, in as little as one or two minutes, a faulty trap is replaced. It is then returned to the storeroom for repair and takes its place as a "spare."

Additionally, each trap hookup offers the following time and cost-saving advantages:

1. Test valve in trap cap to permit fast, easy checking of trap operation so that any failure can be quickly detected to avoid waste.
2. Strainer ahead of trap to protect it against dirt and scale.
3. Blowdown valve in strainer to provide easy cleaning.
4. Check valve in discharge line to isolate trap when test valve is opened.
5. Shut-off valves and unions ahead of and following trap to permit removal of entire trap from line.

No Bypasses

Because of the rapid spare trap interchangeability, there is no need for bypasses to keep a unit in operation in event of trap failure. The cost of bypass installations is avoided, as is the waste that occurs when bypasses are in use, or accidentally left open. (Experience indicates that bypasses are often left open *not* due to trap failure, but due to reducing valve failure which allows steam pressure to exceed maximum trap operating pressure.)

ORIFICE SIZES	
PRESSURE	SIZE
0-40	9/64
40-60	7/64
60-150	5/64

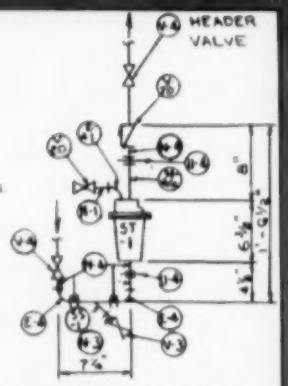
CAPACITY-0-300#/HR

NOTES:

DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.

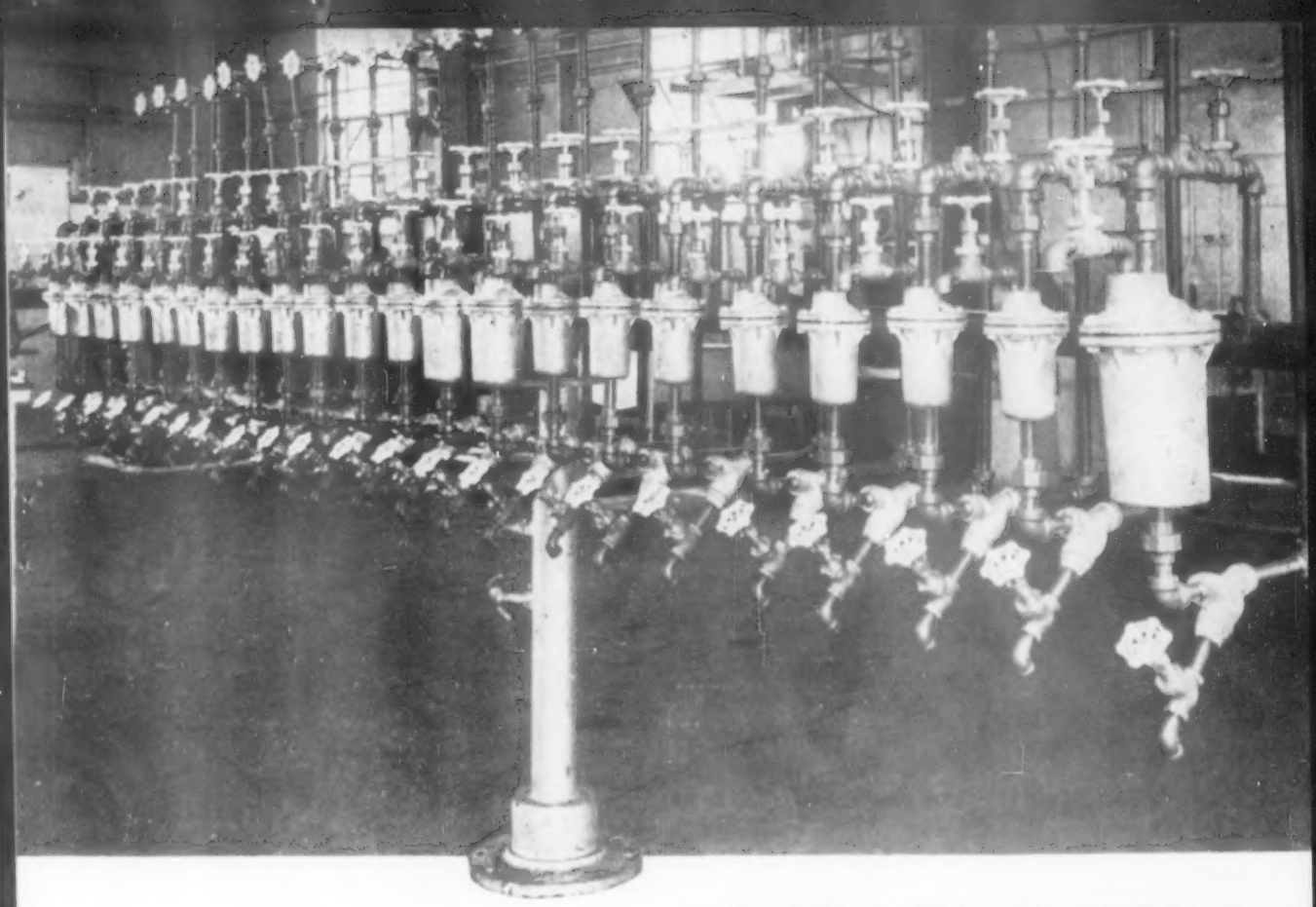
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.

TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.



BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP

MARK	REQD	MAT'L	DESCRIPTION
ST-1	1		½" STEAM TRAP - ARMSTRONG #211
SS-1	1		½" STRAINER - 250# W.S.P. -
V-4	2	BRZ	½" GATE VALVE - SCRD - 200# W.S.P. -
V-20	1	BRZ	½" GLOBE VALVE - SCRD - 200# W.S.P.
V-3	1	BRZ	½" GATE VALVE - SCRD - 200# W.S.P. -
V-70	1	BRZ	½" CHECK VALVE - SCRD - 200# W.S.P. -
E-4	2	MALL. IRON	½" - 90° SCRD ELL - 2000#
E-41	1	MALL. IRON	½" - 90° STREET ELL - 3000# -
U-4	2	MALL. IRON	½" UNION - 2000#
N-1	1	STL	½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3	1	STL	½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4	6	STL	½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4/4	1	STL	½" - 4" LG NIPPLE - SCH 80 - SEAMLESS ASTM A-53



ABOVE: A complete unit trapping manifold hookup made in the customer's piping shop. Note unions, shut-off valves, test valves and strainers for easy maintenance.

Condensate Headers

Another installation technique which saves installation and maintenance cost is the use, wherever possible, of trap manifolds. Traps and manifolds can be assembled in the plant pipe shop under ideal conditions for good workmanship and minimum time consumption. After assembly the manifolds are taken to the site of installation where lines from units in the vicinity are run to the traps. Traps are thus grouped where they can be found easily and where they are readily accessible for inspection and maintenance.

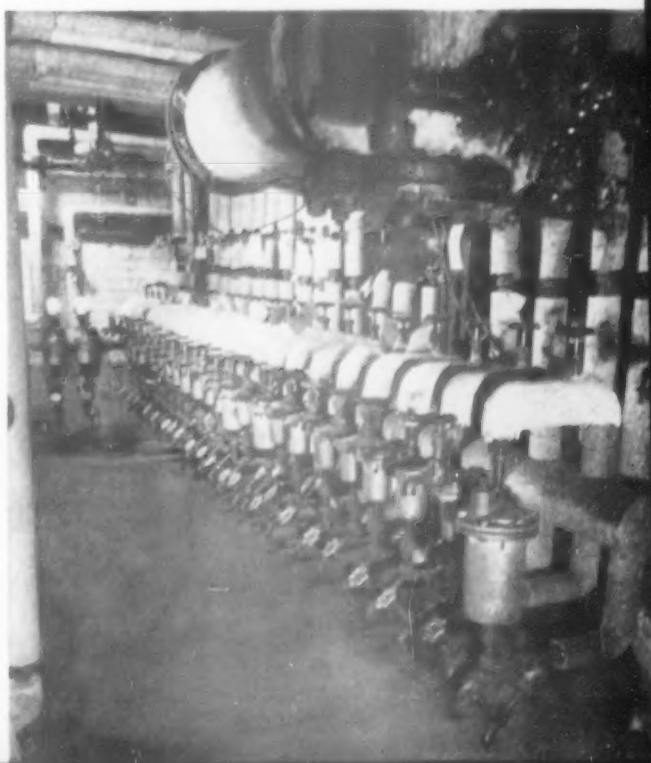
$25,000 Trap Maintenance Saving

Records kept on the Armstrong trap installation described here show that the cost of repair parts and complete replacement traps was approximately $10,000 less annually than with the traps previously used. Reduction in maintenance labor brings the total saving to $25,000 per year. *And fuel savings attributable to the traps are at least equal to the maintenance saving.*

FOR COMPLETE INFORMATION, ask for the No. 1, 1956 issue of the Armstrong Trap Magazine, together with a copy of the Armstrong Steam Trap Book containing complete data on Armstrong traps plus selection, installation and maintenance recommendations. Call your local Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
868 Maple Street • Three Rivers, Michigan

BELOW: Insulation view of trapping hookup pictured above. All traps easily accessible for inspection and maintenance.



This fine plant overseas is just one example of Procon's continually growing accomplishments in petrochemical construction. Like all our projects, it was completed on schedule and up to every specification.

Procon's world-wide construction organization provides a complete service, including new plant construction, additional process facilities, expansion or modernization, to the petrochemical, chemical and oil refining industries. Our services are available to you, any time, anywhere.

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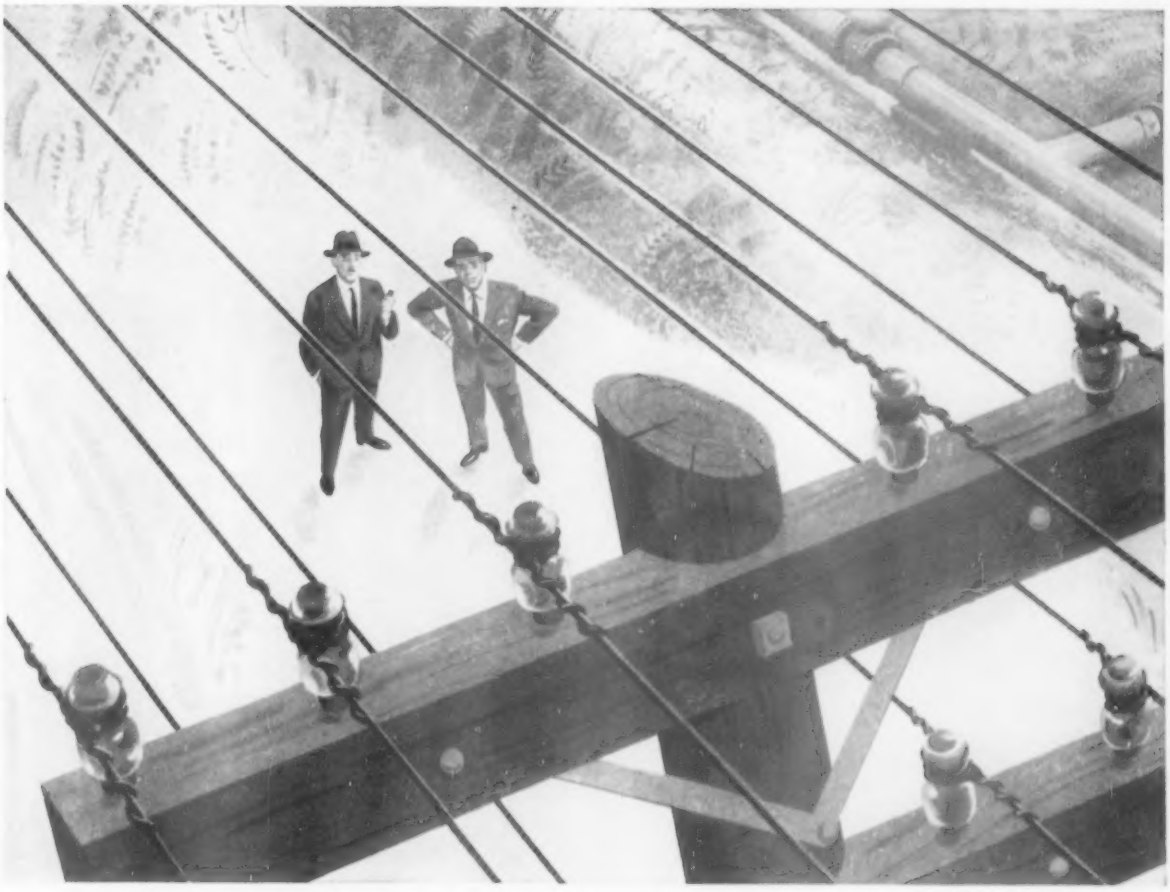

Make full use of the wires you have!

You can save much of the cost of telephone service—simply by using wires you *already own!* These same telephone lines that now link operations up and down the line can bring automatic telephone service to every executive, every department. Now you can afford all the channels you need.

Your Communications Superintendent can tell you how your oil or gas pipeline operation could have its own telephone network with Lenkurt Carrier Equipment and P-A-X Telephone Systems from Automatic Electric.

Lenkurt Carrier Equipment creates, on existing wires, new communication channels for this complete, system-wide telephone service. And *P-A-X Telephone Systems* offer telephones and control equipment to make it completely automatic—lightning-fast, 24 hours a day!

We'll be glad to show you how to plan a complete, integrated communications system to meet your needs. The savings at stake justify your immediate attention! *Call or write* Automatic Electric Sales Corporation (HAymarket 1-4300), 1033 West Van Buren Street, Chicago 7, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

Howard L. Housley	M. G. Gnau	L. C. Wiley
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Dallas, Texas	St. Louis, Mo.	Brownwood, Texas

P-A-X Telephone Systems provide automatic telephone service, using your own circuits. Today, oil and gas pipelines are benefiting from P-A-X Systems.

Lenkurt Carrier Systems provide a simple, economical way to expand circuits. Many pipeline companies have installed Lenkurt Carrier and more than three-fourths of all railroad carrier equipment in the U.S.A. is made by Lenkurt.

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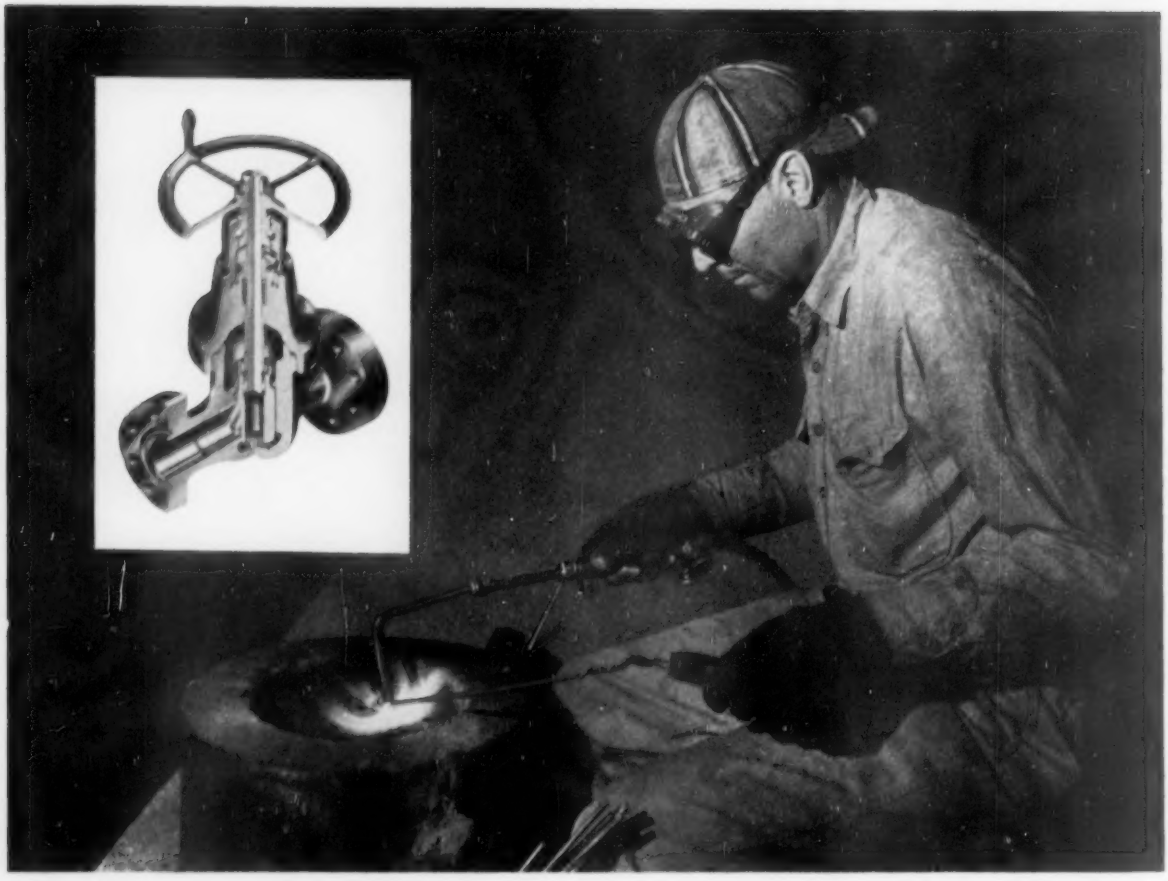
Originators of the dial telephone • Pioneers in automatic control

GENERAL TELEPHONE SYSTEM



Hard Faced, Metal-to-Metal Seal In BIW Non-Lubricated Gate Valve

The entire design of the BIW valve means ease of operation, lower cost of maintenance and longer operational life. The simplified design of the BIW valve is your assurance of long valve life.

The BIW valve seals positively without lubricants. The seating surfaces on both the gate and the seats are faced with a hard, stainless, non-galling alloy. Extensive field service in over 35,000 installations has proved this alloy to be highly resistant to erosion and corrosion.

The hard-faced gate and seat, because of their resistance to wear, make a positive seal for years to come. The BIW valve closes tightly without a lubricant and eliminates the expensive man-hours required for valve lubrication.

Easy opening and closing under pressure is provided by the rugged, heavy-duty steel ball-bearing stem thrust of the valve. The external location of the ball thrust-bearing protects it from possible injury by corrosive well fluids.

Look into the BIW valve. ALCO specialists are available to consult with you. Oil Tool Sales Office, 1404 Dunlavy, Houston 19, Texas, phone JAckson 9-4221.

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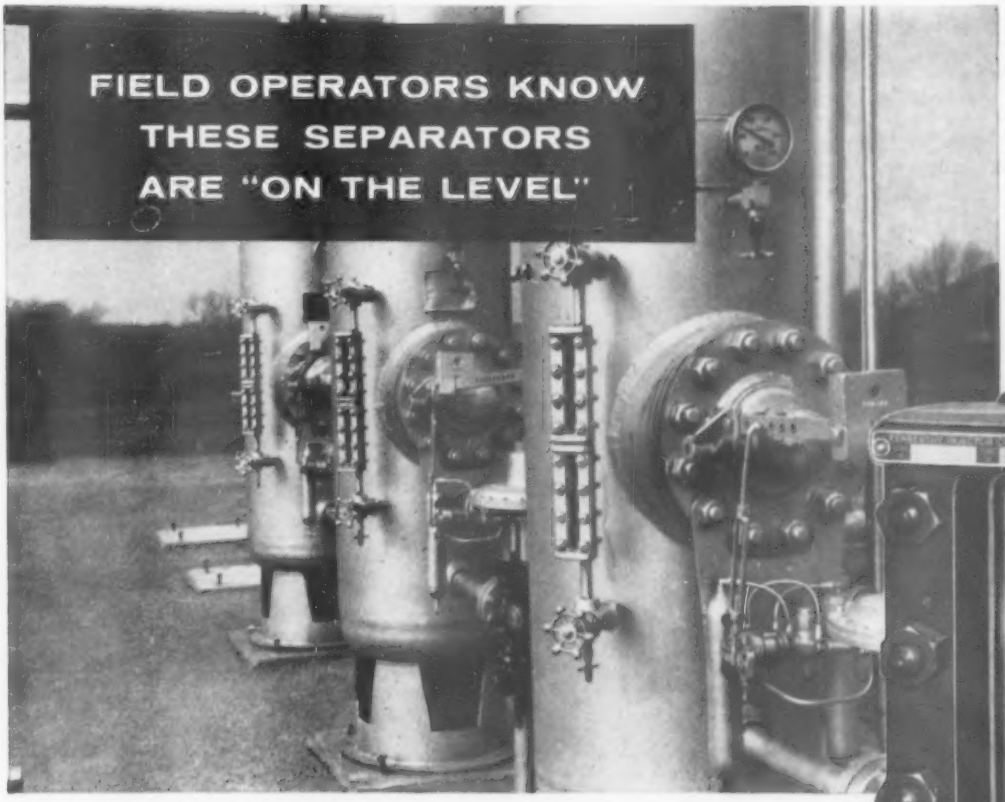

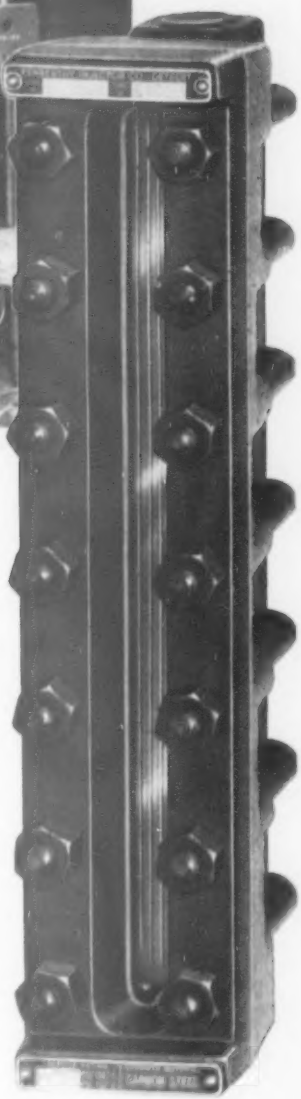

BS&B Equips their Products with

PENBERTHY GAGES

These separators made by Black, Sivalls & Bryson, Inc., are used to extract liquids from air and gas lines. Removal of these liquids prevents damage to compressors and other mechanical equipment. In cold weather, they are helpful in preventing freeze-ups of gas transmission lines.

By standardizing on Penberthy direct-reading liquid level gages for use on vessels where liquid or interface levels must be observed, BS&B assures accurate readings under a variety of temperature and pressure conditions.

Because quality manufacturers, such as BS&B, realize that *less than the best is not good enough* . . . you are seeing more and more Penberthy gages at work on equipment in the Petro-Chemical industry.

Our new catalog #36 will show you why Penberthy products deliver unmatched performance. Write for your copy.

PENBERTHY MANUFACTURING CO.
Division of Buffalo-Eclipse Corporation
1242 Holden Avenue Detroit 2, Michigan

***There's Certain Satisfaction in* PRODUCTS BY PENBERTHY**

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- CYCLING JET PUMPS
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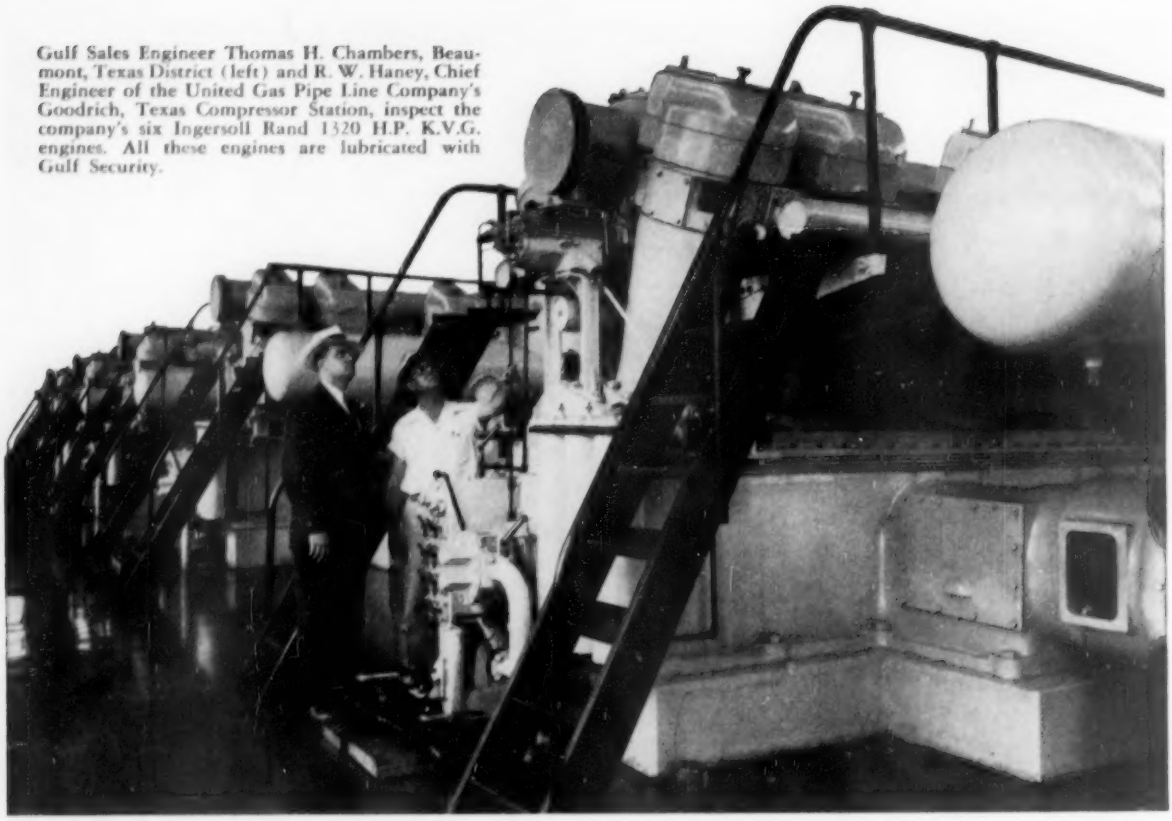
- LIQUID LEVEL GAGES
- GAGE VALVES



Gulf Sales Engineer Thomas H. Chambers, Beaumont, Texas District (left) and R. W. Haney, Chief Engineer of the United Gas Pipe Line Company's Goodrich, Texas Compressor Station, inspect the company's six Ingersoll Rand 1320 H.P. K.V.G. engines. All these engines are lubricated with Gulf Security.

Lock out high maintenance costs in your gas transmission plants

with GULF SECURITY

Gulf Security's outstanding record in the lubrication of pipeline gas engine compressor units is your assurance of smooth, continuous operation. In scores of gas transmission plants this high quality straight mineral oil helps prevent operating troubles and contributes to low maintenance costs.

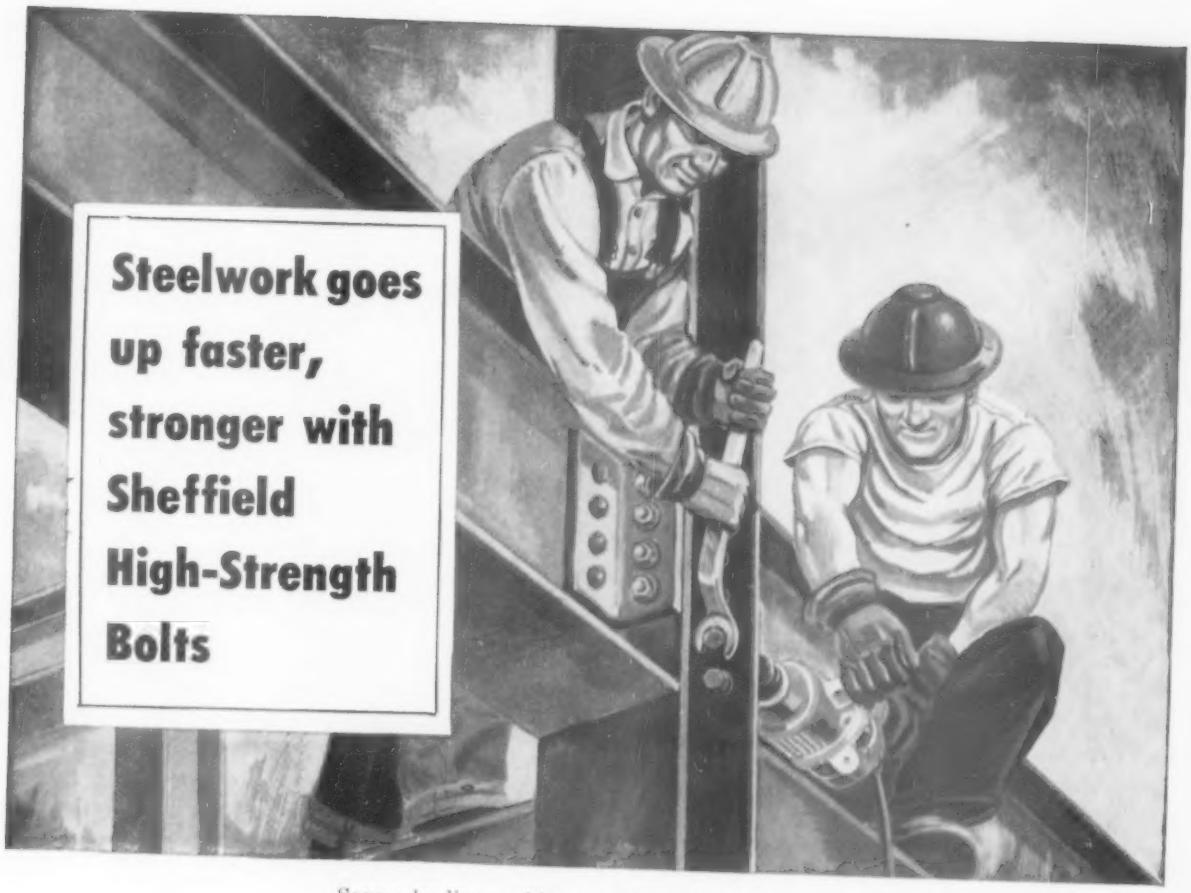
Gulf Security is a non-additive oil that does not cloud liquid filled lubricators of power cylinders, compressor cylinders, and packing glands. After years of operation with Gulf Security, cylinders and piston rings of both compressors and power assemblies show negligible wear, and its excellent oxidation stability helps prevent the formation of acid and resins in the crankcase system.

Make certain your units receive safe, effective lubrication protection—specify Gulf Security. And remember that Gulf provides the services of a trained, experienced petroleum expert—the Gulf Sales Engineer—to help you with any problem involving a petroleum product. Consult the telephone directory for the number of your nearest Gulf office.

GULF

Gulf Oil Corporation • Gulf Refining Company
1822 Gulf Building, Pittsburgh 30, Pa.

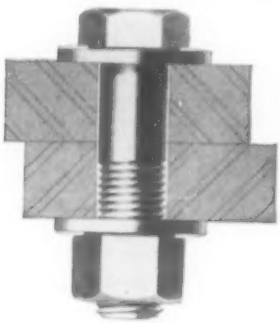
THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS



SHEFFIELD

ARMCO

High-Strength Structural Bolts



Says a leading architectural journal: High-strength bolts are replacing rivets . . . for stronger joints and faster erection . . . at savings up to 40%! More and more designers and builders are proving it with Sheffield High-Strength Bolts.

What's more, it's the answer to a serious labor shortage . . . the growing scarcity of riveters. Two unskilled laborers can be trained in a few days to become an expert bolting team. They can place 350 to 450 high-strength bolts per shift, while a four-man riveting crew is averaging only 175 rivets.

Greater strength: Tests* show two high-strength bolts have the shear strength of three rivets of the same size. **Permanence:** Records show high-strength bolts, tightened to recommended tension, won't loosen . . . even under severe vibrational loads. **Lower costs:** While a high-strength bolt costs more than a rivet, structures go up faster and at less total cost.

A request to your nearest Sheffield office will get you all the facts about Sheffield High-Strength Bolts—successor to the rivet.

Industrial Fasteners Institute

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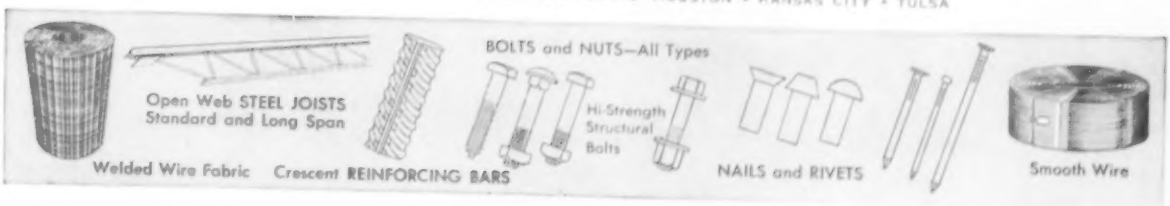
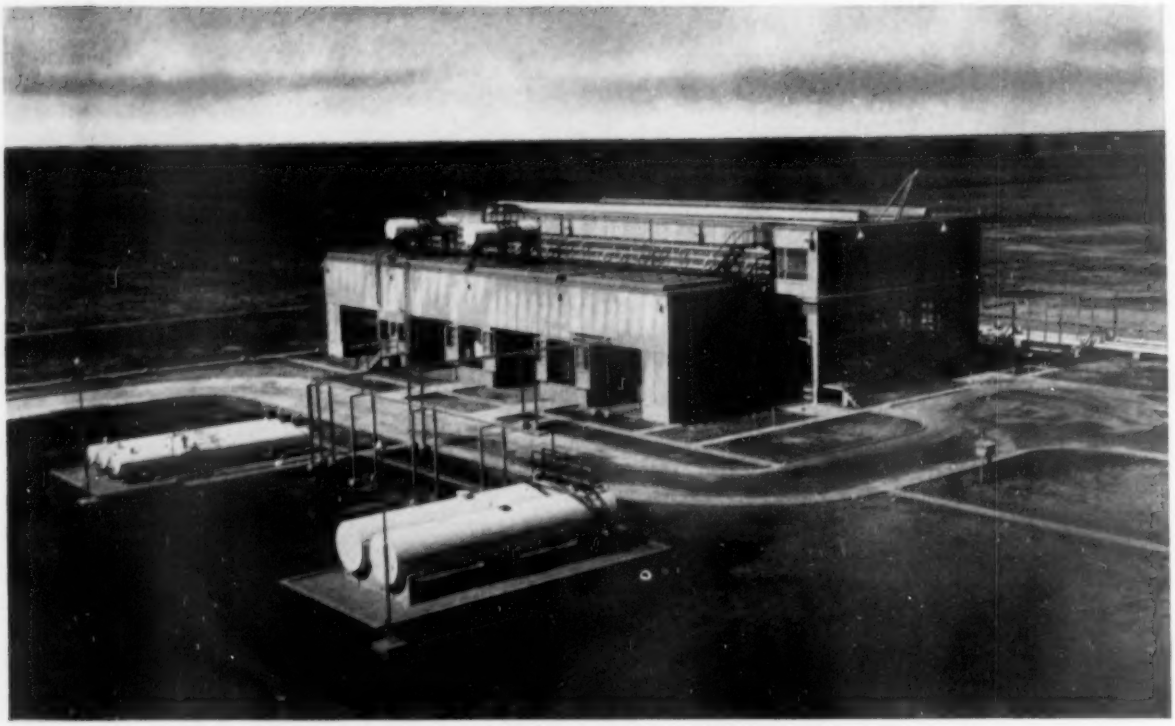




Gýrol Fluid Drive units drive jacket water cooler fans at Gulf Interstate Gas Company stations.

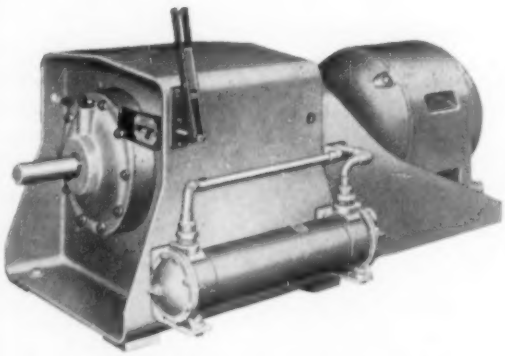
Performance proved! Gýrol® Fluid Drive for automatic control in pipeline stations!

Here are the facts! American Blower Gýrol Fluid Drive gives you stepless, shockless speed control, less equipment wear, lower power consumption, and automatic control in pipeline stations!

Compressor station jacket water coolers. With the Gýrol Fluid Drive, you can vary fan speeds automatically, from minimum to full speed, in relation to engine operation and cooling requirements. And Gýrol units save power, protect jack shafts, too.

Pipeline station pumps. The adjustable-speed, high-horsepower Gýrol Fluid Drive eliminates complex, expensive engines and discharge throttle valves . . . efficiently controls the flow of oils with various densities. That's because the Gýrol unit automatically controls pump speed to deliver the proper throughput and pressure required by the types of oil in the line.

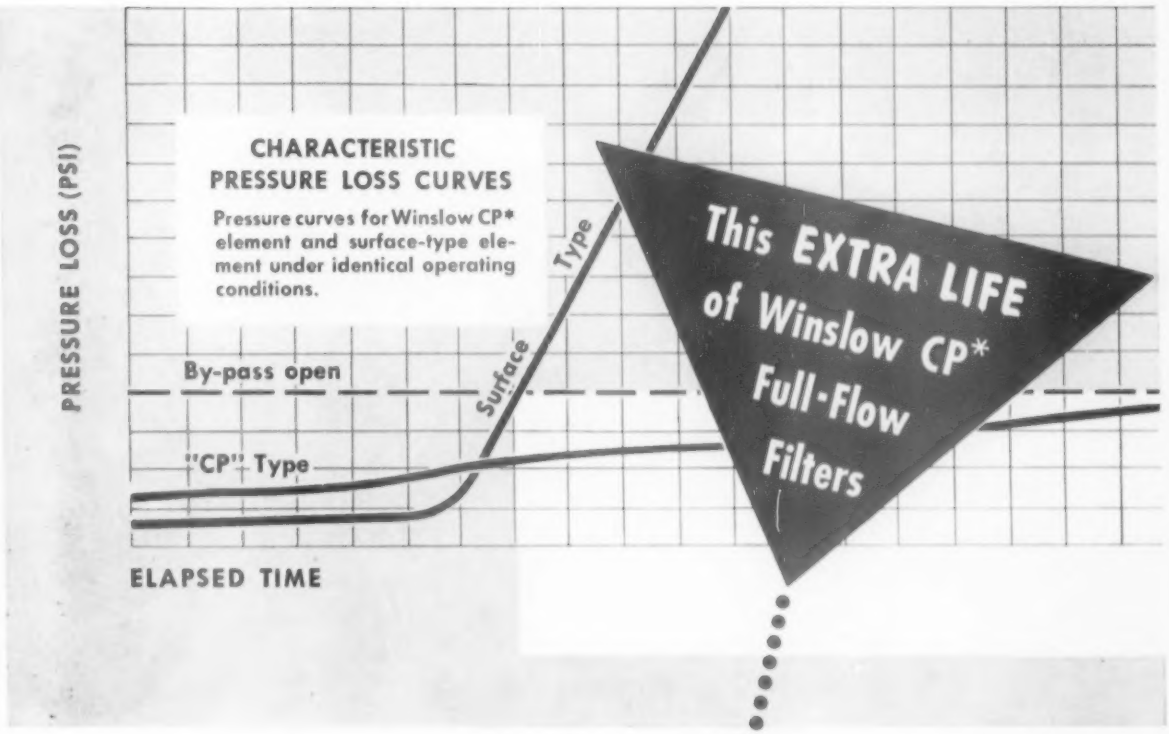
Call our nearest branch office for full information on the Type VS, Class 2, Gýrol Fluid Drive. American Blower Corporation, Detroit 32, Michigan. In Canada, look for Canadian Sirocco products.



Type VS, Class 2, Gýrol Fluid Drive. Sizes from 1 to 800 hp, speeds to 3600 rpm.

AMERICAN BLOWER

Division of American-Standard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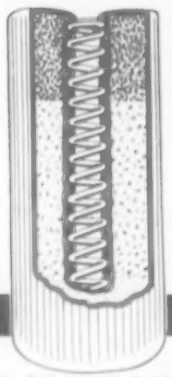
PRESSURE LOSS CURVES
Pressure curves for Winslow CP* element and surface-type element under identical operating conditions.
PRESSURE LOSS (PSI)
By-pass open
"CP" Type
Surface Type
ELAPSED TIME
This EXTRA LIFE of Winslow CP* Full-Flow Filters

Saves both the Oil and the Engine

Laboratory tests and operating experience indicate that Winslow CP* filters have as much as 50% more useful life than a surface-type filter. As a result, both the lube oil and the engine are protected beyond normal filter service.

Contractors, for instance, report that useful oil life in diesel-powered equipment has been extended from 80 hours to 300 hours, with Winslow CP* filters.

Most important, engines are protected all the time with Winslow full-flow filtration . . . protected during cold starts, while idling and against excessive dirt . . . protected if a bearing fails. Because of this better oil filtration, engines last longer and require less maintenance. A modest investment in Winslow filters returns substantial dividends.



THE CP* PRINCIPLE

Winslow patented CP* (Controlled Pressure) elements are designed to continuously self-adjust the pressure within the filter and allow for a full stream of filtered oil from the filter without opening by-pass valves. This is accomplished through the dual flow capacity, with two types of material, as illustrated.

WINSLOW FILTERS **CP is fully protected by patents and trademarks*

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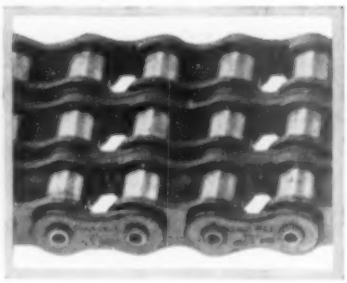
Under the severe loads of oil field drilling service, ordinary roller chains may sometimes develop fatigue cracks around the pin holes in inner pin link plates. But, with Rex Roller Chains you can forget about this. These rugged, long-lasting chains have eliminated frequent premature chain failures.

Pin holes in the inner side plates of Rex Roller Chains have been tremendously strengthened by a special manufacturing process. It's one more cost-cutting, life-saving reason why you should investigate Rex Roller Chains for your rigs... there's no better chain made! For the complete story, see your supply store, your Rex® Field Sales Engineer, or write to CHAIN Belt Company, 4619 W. Greenfield Ave., Milwaukee 1, Wis., for your copy of Catalog No. 55-3.



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There's MORE *Cooling Surface* with Allis-Chalmers MOTORS

Why Rib-Type Motors Won't Fry

STRETCH OUT RIB DESIGN of Allis-Chalmers motors and see the greater cooling area provided — as much as 43% on many models. Insulation won't fry under normal conditions with deep-rib construction because every rib adds to the heat-dissipating surfaces. The result—moderate overloads can be taken in stride with little fear of burnouts.

As a new machinery component or as replacement, specify Allis-Chalmers. To find out more, contact your nearby A-C district office, distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

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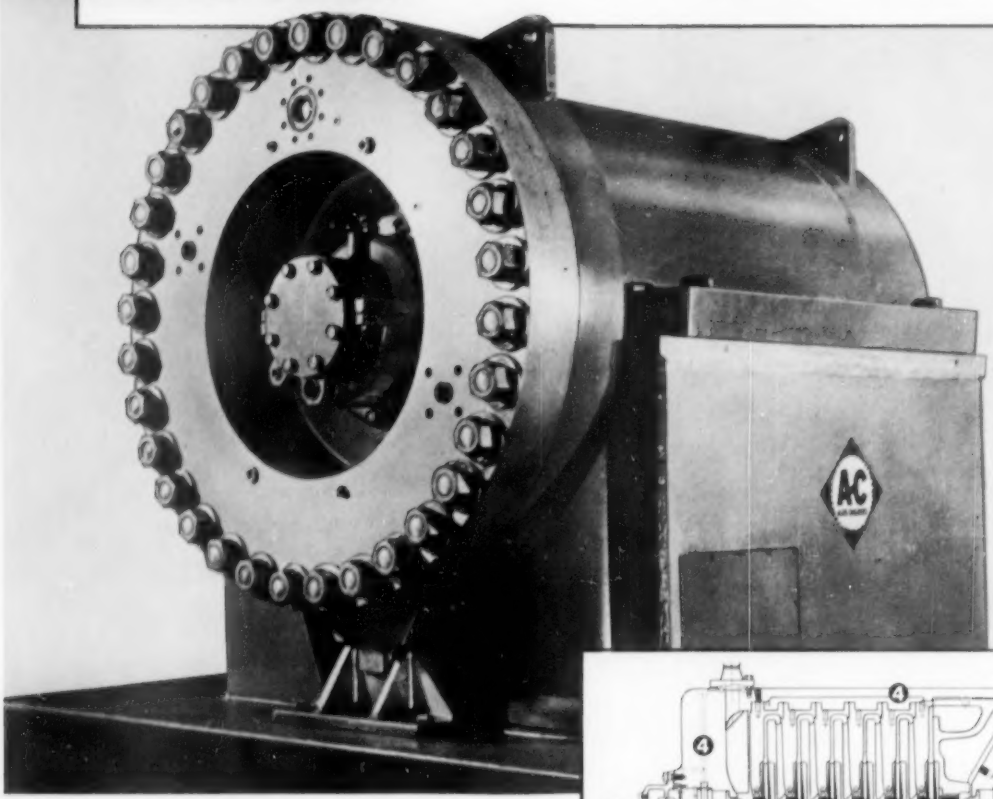
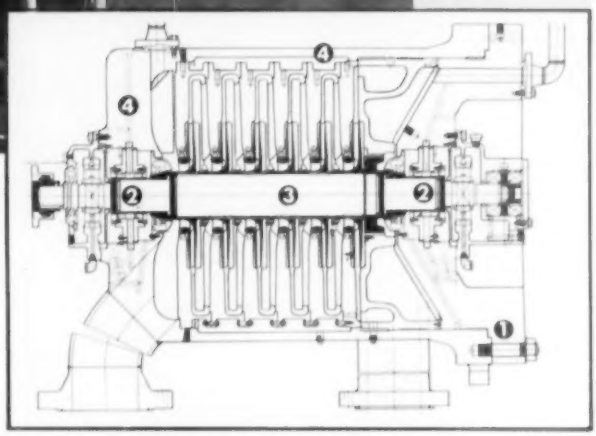
ALLIS-CHALMERS
High Pressure
Barrel-Type
COMPRESSORS

for Non-Stop Service





'Round-the-Calendar Operation is built into the complete line of Allis-Chalmers high pressure barrel-type units for reforming processes. Here are four reasons for their dependability:

1. Simple to Maintain — Only one head bolted. Spiral-wound metallic gasket provides positive seal of casing joint.

2. Shaft Sealing — Double bushing seals have separate high pressure oil system. Inward seal leakage minimized.

3. Rugged Rotor — Impellers shrunk and keyed to shaft. Riveted impellers have rivets milled integrally from blade edge.

4. Extra Strong — Vertically split forged steel casings give maximum safety at high pressures.

Find out more by contacting your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

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A-5107

never before a steam gun like this . . .

So light, so safe and so easy to use

You are looking at the lightest, coolest, easiest-to-handle steam-detergent gun ever developed – the Oakite HURRICLEAN Gun.

It's a featherweight. Weighs only 6¼ lbs.

It's cool, man, cool! Steam travels along insulated *inner* tube. Cool detergent solution flows through insulated *outer* tube.

Handles like a dream! You can't foul-up your hose. Direction of spray changes at a mere twist of outer tube. Hoses stay put!

Easy to operate! Hook it up to your own steam supply and you've got yourself the most devastating grime-buster you ever saw.

The Oakite HURRICLEAN Gun loosens and lifts away stubborn soils from hard-to-reach places.

Use the "HURRICLEAN" Gun to hurry-clean:

- **Pulled heat exchanger bundles**
- **Parts too large for tank immersion**
- **for Paint Stripping**
- **for Drum Reconditioning**
- **for Salvage**

and for general refinery maintenance to help reduce fire risk and to give your plant a fine air of efficiency.

Send for illustrated Bulletin F9737. Gives complete details. Write Oakite Products, Inc., 44C Rector Street, New York 6, N. Y.

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Buried any treasure lately?
If so, did you protect it with BLUE FLAG?

Don't let underground corrosion rob your company of huge pipeline investments. For less than one-half of one per cent of the original cost, you can protect pipelines with Blue Flag Pipe Wrap.

L·O·F Glass Fibers' Blue Flag is made of special inert glass which resists the destructive action of soil chemicals. A Blue-Flag reinforced coating will extend pipeline-life years longer than unreinforced coatings.

What's more, Blue Flag greatly increases wrapping efficiency. High tensile strength virtually eliminates breakage . . . uniform porosity keeps "holidays" to a minimum . . . enamel cold flow is retarded, while strength is increased . . . pipeline coating is protected from backfill damage.

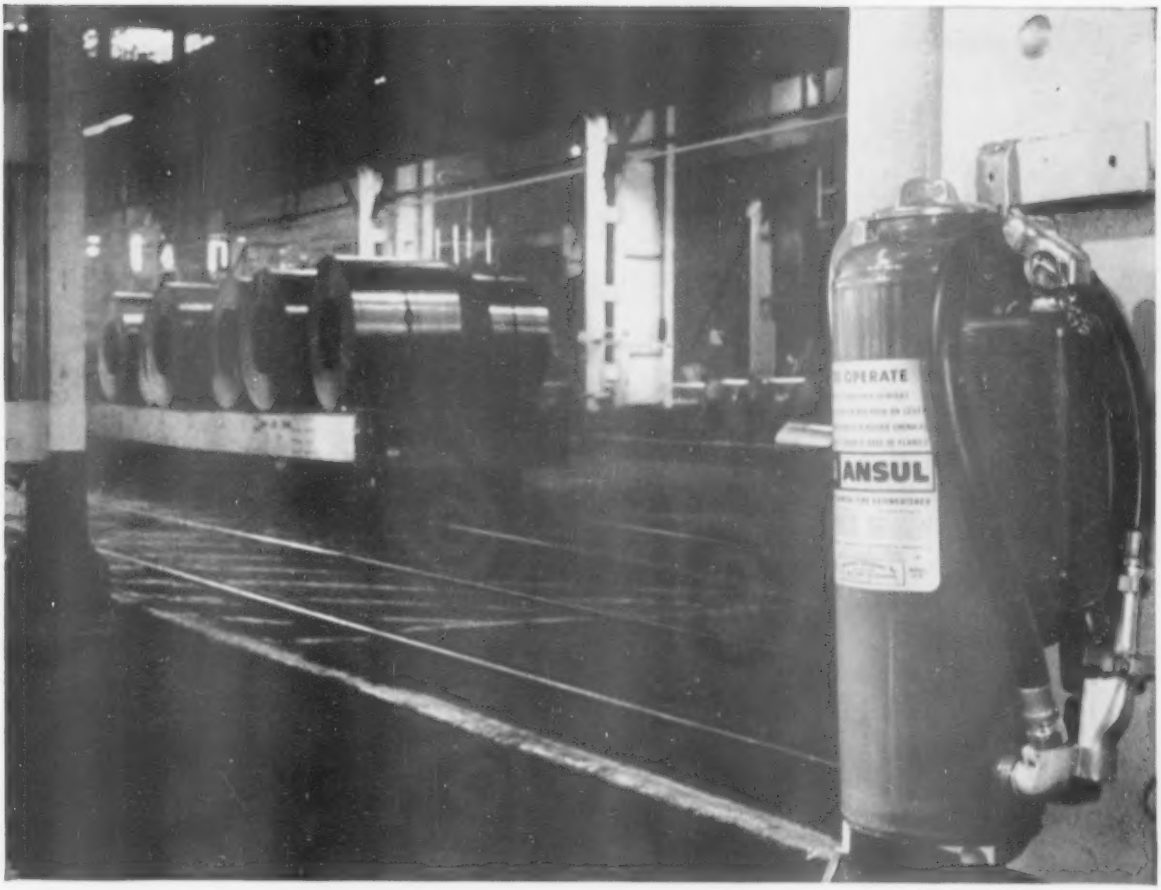
Blue Flag Reinforcing Pipe Wrap is available from a nearby distributor-warehouse. For full details, write: L·O·F Glass Fibers Company, Dept. 78-916, 1810 Madison Avenue, Toledo 1, Ohio.

L·O·F GLASS FIBERS
BLUE FLAG
PIPE WRAP

L·O·F GLASS FIBERS COMPANY
TOLEDO 1, OHIO

Makers of glass fibers by the "Electronic-Extrusion" process

For Complete Pipeline Protection, use: BLUE FLAG Reinforcing Pipe Wrap • **DURAMAT** Protective Outer Wrap • **DURAMESH** Pipeline Fabric • **DURATAPE** Pipeline Joint Wrap



Protect your plant with the same Ansul extinguishers that guard this big steel mill

Well-planned safety and fire prevention programs are doing their share to protect lives, property and production schedules at the Great Lakes Corporation, Detroit, Mich., division of National Steel Corporation. Ansul fire extinguishers are playing a part in this successful program.

Your safety program deserves the best in fire protection. Remember, fire doesn't give you a second chance. Here are three big reasons why Ansul dry chemical extinguishers can take the worry out of your fire protection program and help you maintain a safety record to be proud of:

First. Ansul extinguishers are *dependable.* They are always ready for action, even under severe exposure conditions. Weather-tight construction assures this dependability. *Second.* Ansul extinguishers are *effective.* Patented nozzles deliver either a straight or fan stream, depending upon the hazard. This is an Ansul exclusive for more effective fire control. *Third.* Ansul extinguishers are backed by a *five-year warranty.* This is the best way we know of saying that Ansul extinguishers are the finest of their kind made anywhere. No other manufacturer offers this important warranty.

Get in touch with your local ANSUL MAN through the yellow pages of your phone directory, or write direct to ANSUL CHEMICAL COMPANY, DEPT. OG-9, MARINETTE, WISCONSIN.

ANSUL

CONTINENTAL RED SEALS

for Performance - Economy - Long Life

GASOLINE AND LPG ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N56	4	2¼	3½	56	14.4 @ 2200 RPM
N62	4	2½	3½	62	15.3 @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3 1/16	3½	112	32.0 @ 2400 RPM
F124	4	3	4⅛	124	36.5 @ 2400 RPM
F140	4	3 1/16	4⅛	140	42.0 @ 2400 RPM
F162	4	3 1/16	4⅛	162	49.0 @ 2400 RPM
F186	6	3	4⅛	186	60.5 @ 2400 RPM
F209	6	3 1/16	4⅛	209	68.0 @ 2400 RPM
F226	6	3 1/16	4⅛	226	73.0 @ 2400 RPM
F244	6	3 1/16	4⅛	244	79.0 @ 2400 RPM
M271	6	3⅛	4½	271	86.2 @ 2400 RPM
M290	6	3¼	4½	290	92.2 @ 2400 RPM
M330	6	4	4½	330	104.4 @ 2400 RPM
M363	6	4	4 11/16	363	128.9 @ 2800 RPM
B371	6	4⅛	4½	371	110.0 @ 2400 RPM
B427	6	4 5/16	4½	427	127.0 @ 2400 RPM
G134	4	3½	4½	134	34.0 @ 2000 RPM
G157	4	3½	4½	157	40.2 @ 2000 RPM
E201	4	3½	4½	201	65.4 @ 2400 RPM
H227	4	3⅝	5½	227	54.5 @ 1800 RPM
H243	4	3¾	5½	243	58.0 @ 1800 RPM
H260	4	3⅞	5½	260	62.2 @ 1800 RPM
H277	4	4	5½	277	66.4 @ 1800 RPM
K363	6	4	4 11/16	363	123.0 @ 2400 RPM
J382	4	4½	6	382	74.0 @ 1400 RPM
T371	6	4⅛	4½	371	119.0 @ 2400 RPM
T427	6	4 5/16	4½	427	140.0 @ 2400 RPM
U501	6	4½	5⅛	501	159.0 @ 2400 RPM
R513	6	4½	5⅛	513	164.3 @ 2400 RPM
R572	6	4¾	5⅛	572	182.4 @ 2400 RPM
R602	6	4⅞	5⅛	602	191.7 @ 2400 RPM
V603	8	4¾	4½	603	220.0 @ 2800 RPM
S749	6	5⅛	5½	749	217.0 @ 2200 RPM
S820	6	5⅛	5½	820	237.0 @ 2200 RPM

CUSHIONED POWER DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
ZD129	4	3¼	3⅞	129	34.0 @ 2000 RPM
GD157	4	3⅜	4⅛	157	39.0 @ 2000 RPM
*ED201	4	3⅝	4⅛	201	45.8 @ 2000 RPM
HD243	4	3¾	5½	243	55.0 @ 2000 RPM
*HD260	4	3⅞	5½	260	59.0 @ 2000 RPM
*HD277	4	4	5½	277	63.0 @ 2000 RPM
*JD382	4	4½	6	382	72.5 @ 1600 RPM
TD427	6	4 5/16	4⅛	427	106.0 @ 2000 RPM
RD572	6	4¾	5⅛	572	154.0 @ 2000 RPM
VD603	8	4¾	4¼	603	175.0 @ 2600 RPM
SD802	6	5 5/16	5½	802	202.0 @ 1800 RPM

*Available for industrial applications only.

One reason for the oil field's widening acceptance of Red Seal power is the diversification of the Red Seal line. Long-range satisfaction with any piece of equipment depends largely on the closeness with which the engine is matched to its work. And with 47 different basic models from which to choose—each capable of still closer tailoring to the job's specific needs, through specification changes—your requirements can be met exactly, no matter what the application.

SERVICE AND GENUINE RED SEAL PARTS SOLD EVERYWHERE

Continental Motors Corporation

MUSKEGON • MICHIGAN

6 EAST 45TH STREET, NEW YORK 17, NEW YORK • 6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 3817 SOUTH SANTA FE AVENUE, LOS ANGELES 58, CALIFORNIA • 1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GEORGIA

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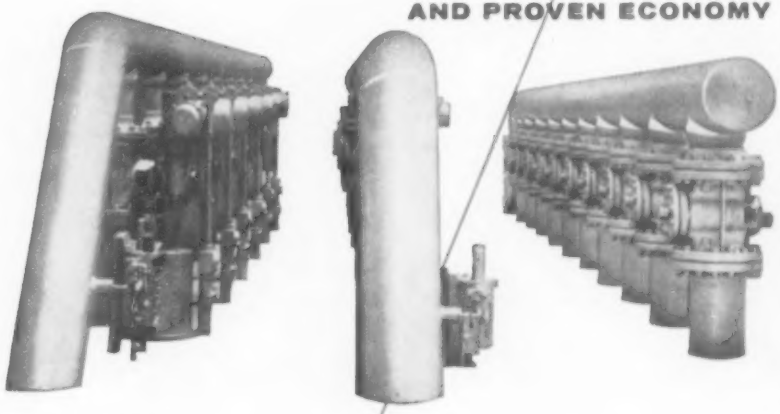
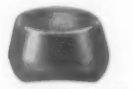
WELDOLETS

FOR ASSURED STRENGTH

AND PROVEN ECONOMY



WELDOLETS



THREDOLETS

SOCKOLETS

Are you effecting this economy for your company? Neat and uniform appearance is evident in code constructed weldolet headers in this crude oil pipeline terminal. The money saved is in the bank and does not appear in this picture. If you are not using the weldolet method of cutting piping costs, write today for information.

SOLD THROUGH LEADING DISTRIBUTORS

BONNEY

PENNSYLVANIA DIVISION

BONNEY FORGE & TOOL WORKS

366 GREEN ST., ALLENTOWN, PA.

CUT WELDING FITTING COSTS

You spend 2 to 20 times as much for a welding tee as you do for a Weldolet.

CUT INSTALLATION COSTS

Compared with these methods of branch construction . . .

WELDING TEES

You save line-up and beveling time in addition to welding time by using WELDOLETS.

REINFORCED NOZZLES

You save all shaping and fitting time in addition to a tremendous saving in welding time by using WELDOLETS.

UNREINFORCED NOZZLES

You save all shaping and fitting time by using WELDOLETS.

COUPLINGS

You save all shaping and fitting time and welding time by using THREDOLETS.

SPECIFY AND USE—

Weldolets for branches 2" through 24" on full size and reducing size.

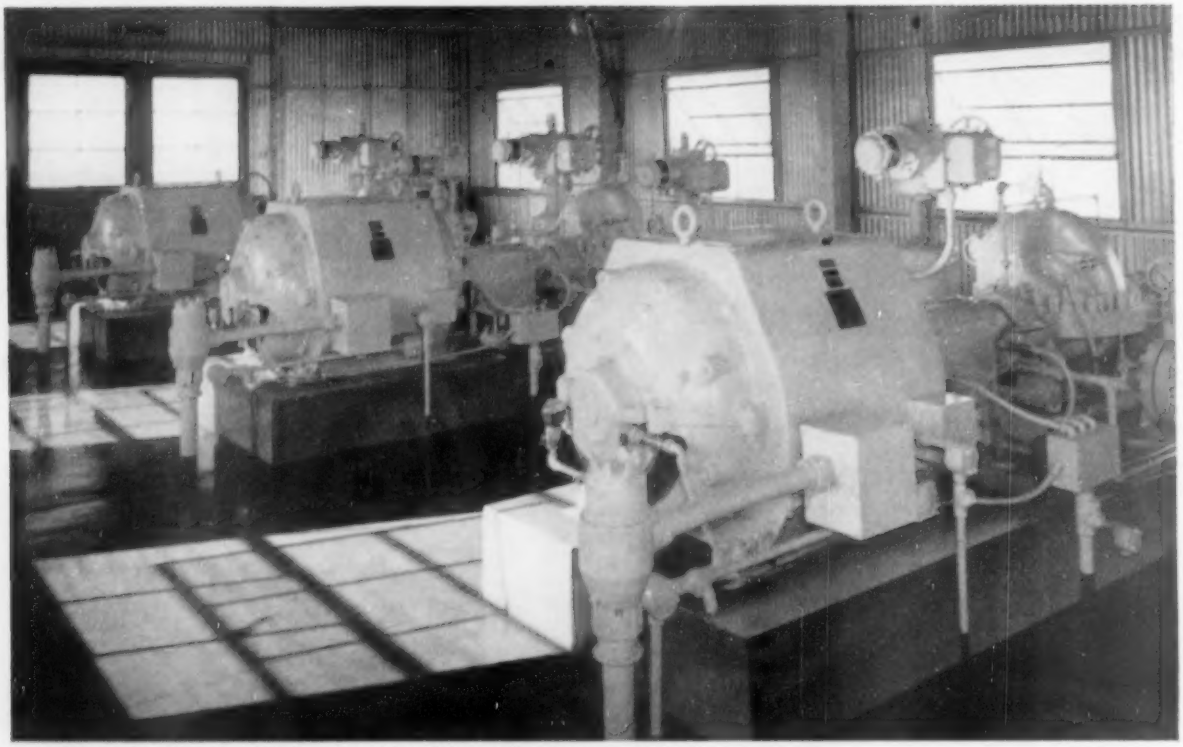
Thredolets or Sockolets for branches ⅛" through 2".

AVAILABLE—

Weights—all through XXS.

Materials—Carbon
Stainless
Chrome Moly
Wrought Iron
Monel
Copper Nickel
Bronze
Aluminum

Warehousing Distributors in principal cities.



DOWN IN CRESSON, TEXAS, three Louis Allis 500-hp, 3600-rpm, 2300-volt open motors drive centrifugal pumps at main-line station of a major oil company.

STATIONS STAY ON-STREAM

with Louis Allis Motors built to pipeline requirements

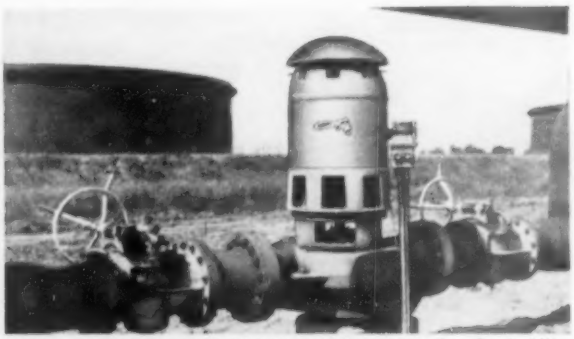
There is a Louis Allis Motor designed specifically for your pipeline job—one with long-life features that protect against costly downtime and maintenance.

Where a Louis Allis standard motor doesn't fill the bill exactly, you can get prompt delivery on a unit specially designed to give you the electrical and mechanical characteristics best suited to your needs.

Contact your nearby Louis Allis Field Engineer—or write us—for a solution to your motor problem, based upon our more than 50 years' experience.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

TRANSFER TERMINAL IN CORPUS CHRISTI is equipped with three Louis Allis 200-hp, 3600-rpm, 440-volt motors.



THIS VERTICAL BOOSTER PUMP is driven by a Louis Allis 350-hp, 3600-rpm explosion-proof motor.

ANOTHER LINK IN A MILLION-MILE CHAIN

This 30-foot section of pipe has been coated, wrapped, and is ready for service. It will take its place in the vast underground pipeline network that moves a greater volume than do trucks, railroads, ships and planes, combined.

It will become part of a great subterranean system that is vital to America's everyday living.

Let the facts speak for themselves. The gas industry alone handles over 10,000,000,000,000 cubic feet daily through more than half a million miles of transmission and distribution pipelines. A 185,000-mile pipeline system moves liquid petroleum products across the continent. In addition, there are many thousands of separate pipeline systems used to transport steam for power and heating —and to deliver water through municipal piping.

But there are problems—and one of the most important of these is corrosion. Pipeline companies and utilities must protect their metal pipe against the many corrosive elements that exist underground.

That's where Dearborn comes in. Dearborn's complete line of NO-OX-ID Coatings and NO-OX-IDized Wrappers provide both chemical and mechanical protection against moisture penetration and soil action—protection that lasts for decades—under ground or under water. That's why leading pipeline companies and utilities everywhere look to Dearborn for long-term protection against corrosion leaks and deterioration.

We will gladly consult with your engineers on the best NO-OX-ID Coating and Wrapper Combination for your next pipeline job.

SPECIFY

Dearborn NO-OX-ID®

ON YOUR NEXT PIPELINE JOB

USE THE COUPON FOR MORE INFORMATION

Dearborn Chemical Company, Dept. OG
Merchandise Mart Plaza, Chicago 54, Ill.

☐ Please send details on NO-OX-ID Combinations.
☐ Have representative call.

Name.....*Title*.....

Company.....

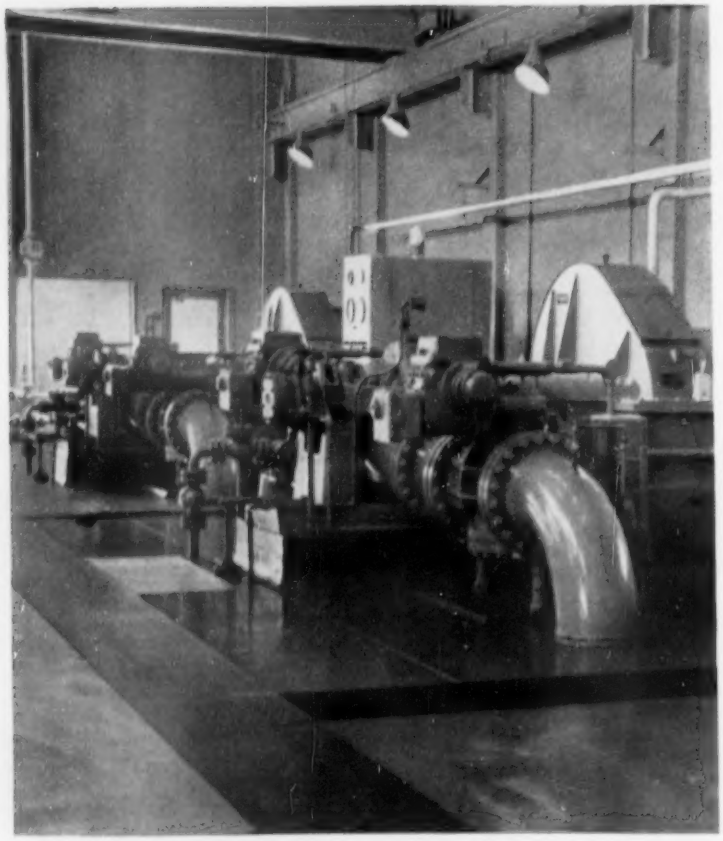
Address.....

City.....*Zone*.....*State*.....

Interprovincial-Lakehead pipe line — owned and operated in Canada by the Interprovincial Pipe Line Company, and in the United States by Lakehead Pipe Line Company. Transports heavy grade of crude oil. Rated capacity: western end, 185,000 barrels per day; eastern end, 105,000 barrels per day.

WORLD'S LONGEST CRUDE OIL LINE

served by 21 Farrel® speed increasers



Two of three Farrel speed increasers at Saxon (Wisconsin) pumping station.

The Interprovincial-Lakehead pipe line — longest crude oil line in the world — runs from the oil fields near Edmonton, Alberta, to the large Canadian refineries at Sarnia, Ontario. Nine Farrel speed increasers transmitting 1800 HP each and twelve others rated at 800 HP each, serve the pumping stations located in the United States.

The Saxon (Wisconsin) station, newest in the line, gets its pumping power from three 1760 BHP turbocharged Diesels driving centrifugal pumps through Farrel speed increasers. The gear units increase the 500 RPM engine speed to a pump speed of 3600 RPM.

Of the hundreds and hundreds of Farrel units installed throughout the world, not one has ever been replaced. Even the first units, built twenty-five years ago, are still in service. Next time you're in the market for speed increasers, remember the amazing record of Farrel units. It's a virtual guarantee of trouble-free performance.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.

Sales Offices: Ansonia, Buffalo, Boston, Akron, Detroit, Chicago, Minneapolis, Fayetteville (N.C.), Los Angeles, Salt Lake City

Oil Field Representatives:

Hercules-Lupfer Engine Sales Co., 124 N. Boston St., Tulsa 1, Okla.

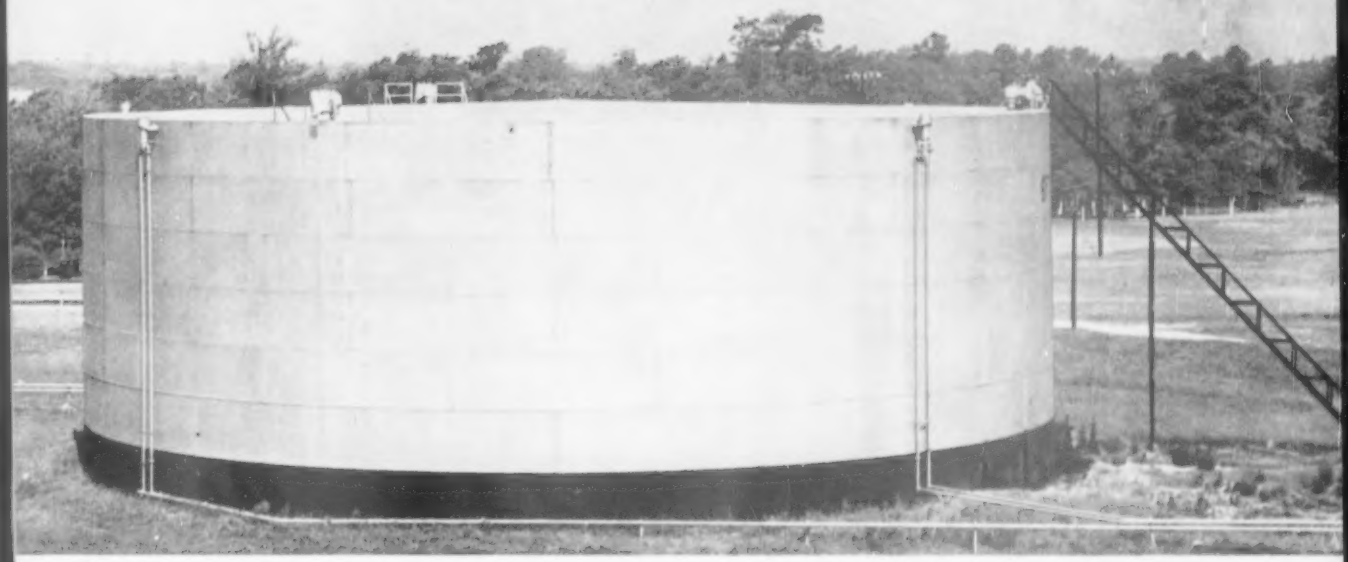
V. W. Osborne, 860A M&M Bldg., Houston 2, Texas

Farrel-Birmingham®

FB-1072

Sinclair tank reduces evaporation every working hour

with Microballoon spheres*



Test tank has a discharge rate of 2000 bbl. per hour, with five turnovers per month. Average temperature is 75 deg. F., RVP is 5.6 psi. Since its evaporation loss was about half that of the control tank, additional tanks at this **Sinclair Refining Co.** location are due for this system of evaporation control.

For more than two years, Sinclair Refining Co. has had one of its older 80,000-bbl. cone-roof tanks at Houston, Texas, equipped with a vapor-stopping seal of Microballoon* spheres made from BAKELITE Brand Phenolic Resins.

Results of this test now show that evaporation loss was approximately half that of the control tank, which had no seal.

The effective use of the foam seal treatment can help you reduce needless waste due to evaporation.

To learn more about this method of control, write Bakelite Company, or *Chicago Bridge & Iron Company, Chicago 4, Ill.*

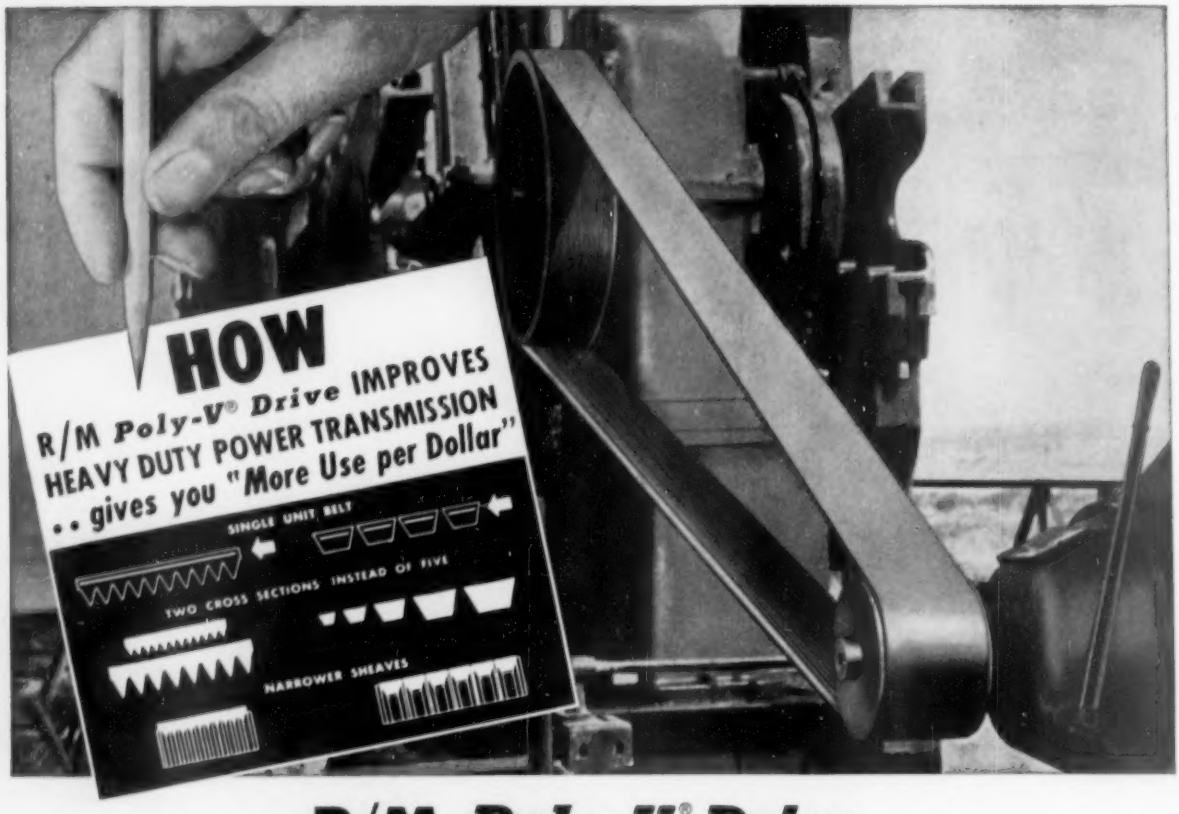
*Registered trade-mark of The Standard Oil Co. (Ohio)

for evaporation control . . .

BAKELITE BRAND RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC



R/M *Poly-V® Drive*
Delivers More Power in Less Space!

No other belt drive can deliver as much power in the same space. It's R/M's patented Poly-V* Drive developed by R/M engineers after years of research. This totally new concept in power transmission delivers up to 50% more power than a conventional V-belt drive of equal width.

Unique design accounts for the unusual power capacity of R/M Poly-V Drive. A *single, endless* belt with parallel V-ribs runs on sheaves specially designed to mate precisely with the belt ribs. The uniform pull of this single unit belt distributes drive load evenly over the full width of the sheave . . . gives higher horsepower capacity per inch of drive width than ever before possible.

There are many advantages in this space saving drive . . . Poly-V has eliminated the matching problems of multiple V-belt drives, greatly increased the life expectancy of belts and sheaves and maintains more constant speed ratios under all loads. Just *two* cross sections of Poly-V meet every heavy duty power requirement . . . costly belt and sheave inventories are kept to a new low! R/M Poly-V Belts have strength members of superior synthetic cords, are oil-proof, non-spark and heat resistant.

Let an R/M representative demonstrate how you can improve your power transmission applications . . . get "More Use per Dollar" . . . with R/M Poly-V Drive. Contact R/M . . . or write for Poly-V* Drive Bulletin #6638.

CONDOR V-BELTS • R/M SUPER-POWER V-BELTS

Write for Bulletin #6868 on the complete line of Condor V-Belts for regular service on conventional V-belt drives. Also write for Bulletin #6628 on R/M Super-Power V-Belts with 40% more Horsepower capacity where needed.

*Poly-V is a registered Raybestos-Manhattan Trademark RM 606

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Laundry Pads and Covers • Bowling Balls

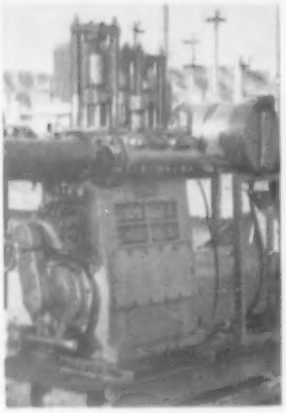
"And I say it has to be an ALDRICH PUMP!"

Continuous, heavy duty pumping operations, often at high pressures, demand the complete reliability and freedom from maintenance found only in an Aldrich Pump. Top performance under these conditions has earned Aldrich its reputation for building pumps of highest quality and dependability.

The tougher the job . . . the more important it becomes to take advantage of our wide experience in providing the petroleum industry with pumps for water flood, pipeline, gasoline plant, hydrocarbon injection or petrochemical service.

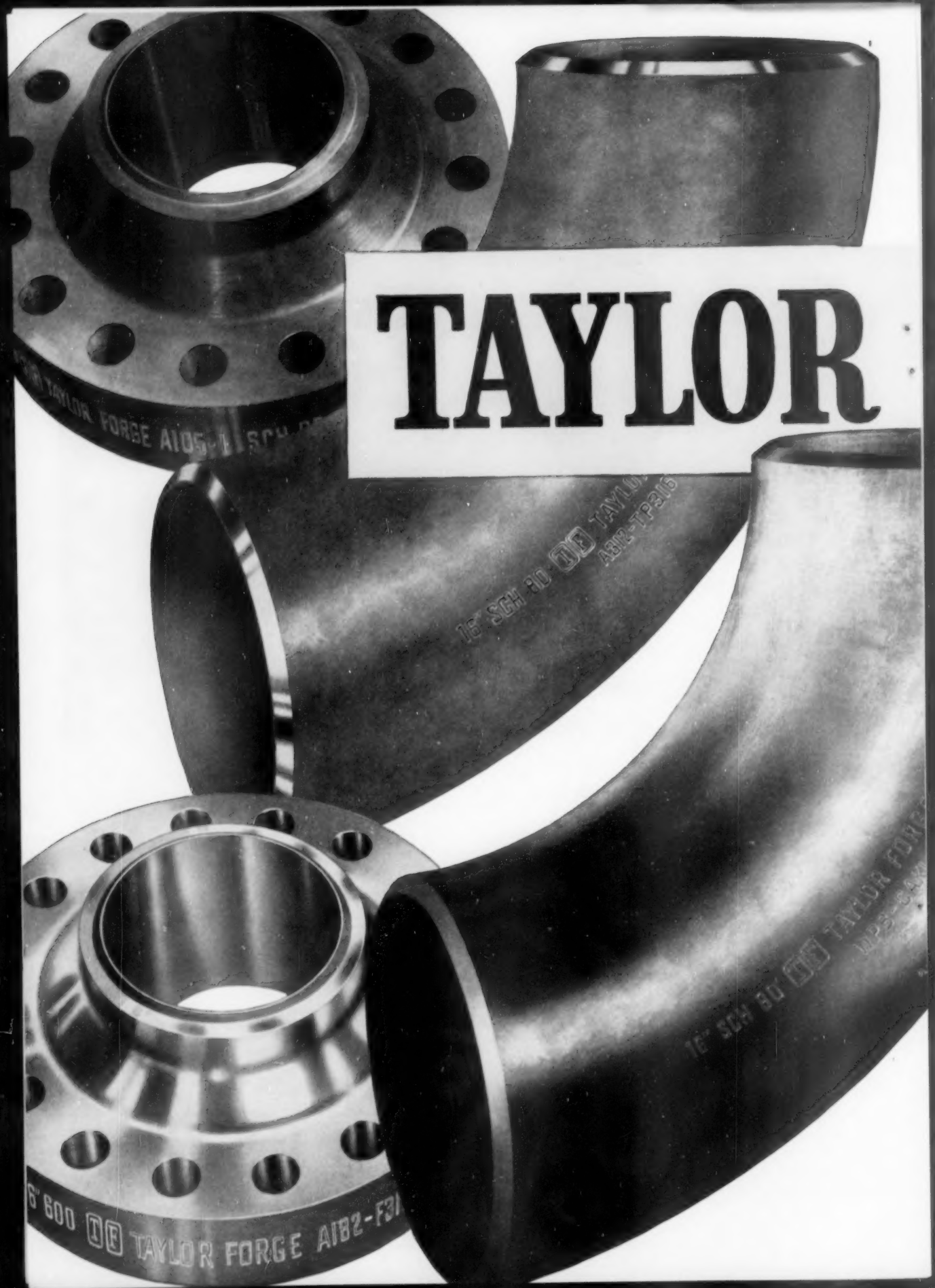
In the less critical jobs, too . . . it makes sense to call Aldrich. The simplicity of the Aldrich Direct Flow design, with fluid-end sectionalization and automatically controlled delivery, offers substantial economies in both operation and maintenance.

A copy of our new condensed catalog, showing the line of Aldrich Pumps is yours for the asking. Write for Data Sheet 100. The Aldrich Pump Company, 9 Gordon Street, Allentown, Pa.



Shown above is one of a number of Aldrich 5" stroke, Triplex Pumps installed at a major west coast water injection project. These pumps are currently handling 35,000 bbl daily at injection pressures of 1,000 psi.

THE ALDRICH PUMP COMPANY


TAYLOR
TAYLOR FORGE A105-1
16" SCH 80 TAYLOR A312-TP316
16" SCH 80 TAYLOR FORGE
6" 600 TAYLOR FORGE A182-F3

T F ⬅ The mark of excellence..

FORGE

Welding Fittings and Forged Flanges

It's a small thing to look for . . . that TF mark on every Taylor Forge product. But it's a very important thing to find. For it is your assurance of service, safety and long life . . . your guarantee of unvarying accuracy, consistent uniformity, and maximum strength.

Taylor Forge Welding Fittings and Forged Flanges . . . backed by 55 years of experience . . . meet all American Codes and Standards. They're available in stainless steels as well as carbon steel and all forgeable materials . . . in every size, type, thickness and pressure rating.

Taylor Forge & Pipe Works

General Offices and Works: P. O. Box 485, Chicago 90, Illinois

Plants at: Carnegie, Pa., Gary, Ind., Houston, Texas, Fontana, Calif., Hamilton, Ont., Canada

District Sales Offices: New York, Boston, Philadelphia, Pittsburgh, Atlanta, Chicago, Houston, Tulsa, Los Angeles, San Francisco, Seattle, Toronto, Calgary.

FOR GENUINE SERVICE . . . CALL YOUR TAYLOR FORGE DISTRIBUTOR

He carries a full stock of Taylor Forge Welding Fittings and Forged Flanges and can supply your needs promptly. He's a good man to know for he understands piping and through him you have available the services of Taylor Forge engineers for help and advice on any piping problem.

To be sure . . . turn to Taylor Forge . . . . . TRADITIONALLY DEPENDABLE

Welding nozzles

T.E.M.A. flanges and channels

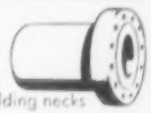
Multiple outlet headers

Production forgings

Venturi reducers

Spiral weld pipe

Large diameter electric weld pipe



Welding necks

Chicago, Illinois . . . where Dow caustic serves alkali formulators.

DOW

wherever you're producing

DEPENDABLE CAUSTIC SODA DELIVERY IS ASSURED FROM DOW

Dow is the one producer, you know, supplying caustic soda to industry everywhere. Wherever you produce, you're *sure* of getting rapid, dependable service from Dow.

The *three* modern Dow plants and *six* additional shipping terminals . . . stretching from Bayonne, New Jersey to Los Angeles, from Chicago to Freeport, Texas . . . start the order to you immediately on your teletype, wire or call. Ocean-going tankers, inland barges, tank cars and tank trucks . . . the full facilities of the industry's most extensive and flexible distribution network go to work without delay, getting Dow caustic to you *now*.

Then, too . . . Dow customers benefit from continual process research, stringent quality control in plant and in transit, prompt field technical service. Does Dow have *your* order? THE DOW CHEMICAL COMPANY, Dept. AL 756C, Midland, Michigan.

you can depend on DOW CHEMICALS DOW

FILL 'ER UP!

WHEATLAND STEEL PIPE

serving the Gas and Oil Industry

LINE PIPE IN ACCORDANCE WITH AMERICAN PETROLEUM INSTITUTE SPECIFICATIONS

- pipe with the yearmark!

WHEATLAND TUBE COMPANY

BANKERS SECURITIES BLDG., PHILA. 7, PA. MILLS • WHEATLAND, PA. • DELAIR, N. J.

NEW! PHILCO

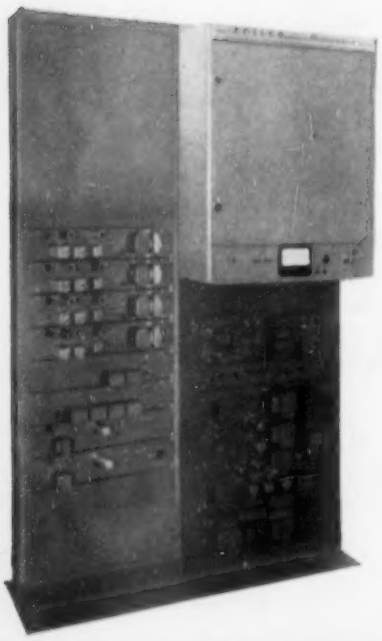
HERE are new Microwave "Packages" by Philco, pioneer in the design and manufacture of microwave systems. Each new package incorporates advanced techniques in communications and control. All components have been selected for superior performance and greatest reliability. Outstanding features of Philco Microwave Packages can lower your installation and operating costs; write Philco now for complete information.

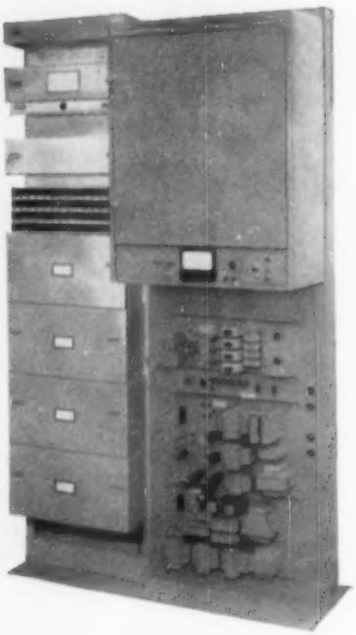
PHILCO Series 500 ▶

Philco Series 500 Package is designed primarily for pipe line and railroad companies requiring maximum dependability consistent with highest commercial performance standards along extensive right-of-way routes.

FEATURES

- Expandable to 24 or more channels (plus service channel)
- Extendable to 40 hops (1000 miles)
- Commercial quality circuits





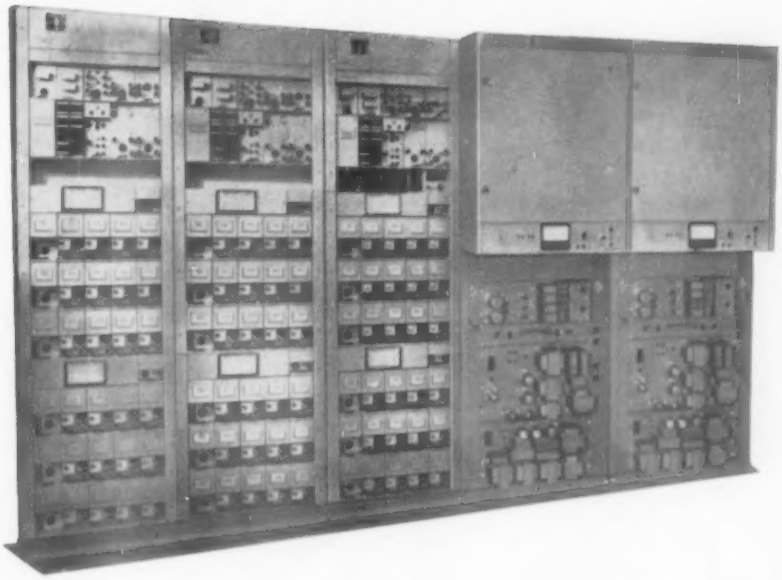
◀ PHILCO Series 120

Philco Series 120 Package is designed to provide low cost, reliable communications over moderate distances for turnpikes, police, and utilities.

FEATURES

- Lowest cost per channel mile
- Expandable to 24 or more channels (plus service channel)
- Extendable to 10 hops
- Commercial quality circuits

Microwave "Packages"



PHILCO Series 90

Philco Series 90 Package is designed to provide the high performance and reliability required by common carriers and government agencies. Full 100% standby with completely automatic switching is included.

FEATURES

- Utmost reliability
- Expandable to 60 channels
- Extendable to 5 or more hops

Philco maintains a staff of experienced engineers to conduct surveys, plan, and install complete systems to satisfy even the most complex communications requirements. These men have successfully completed thousands of system miles, including one of the longest microwave communications systems in the world.

Write to Dept. OG for New Free Booklet

PHILCO
Famous for
QUALITY
the World Over

PHILCO CORPORATION

GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44 PENNSYLVANIA

In Canada: Philco Corporation of Canada, Limited, Don Mills, Ontario

This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

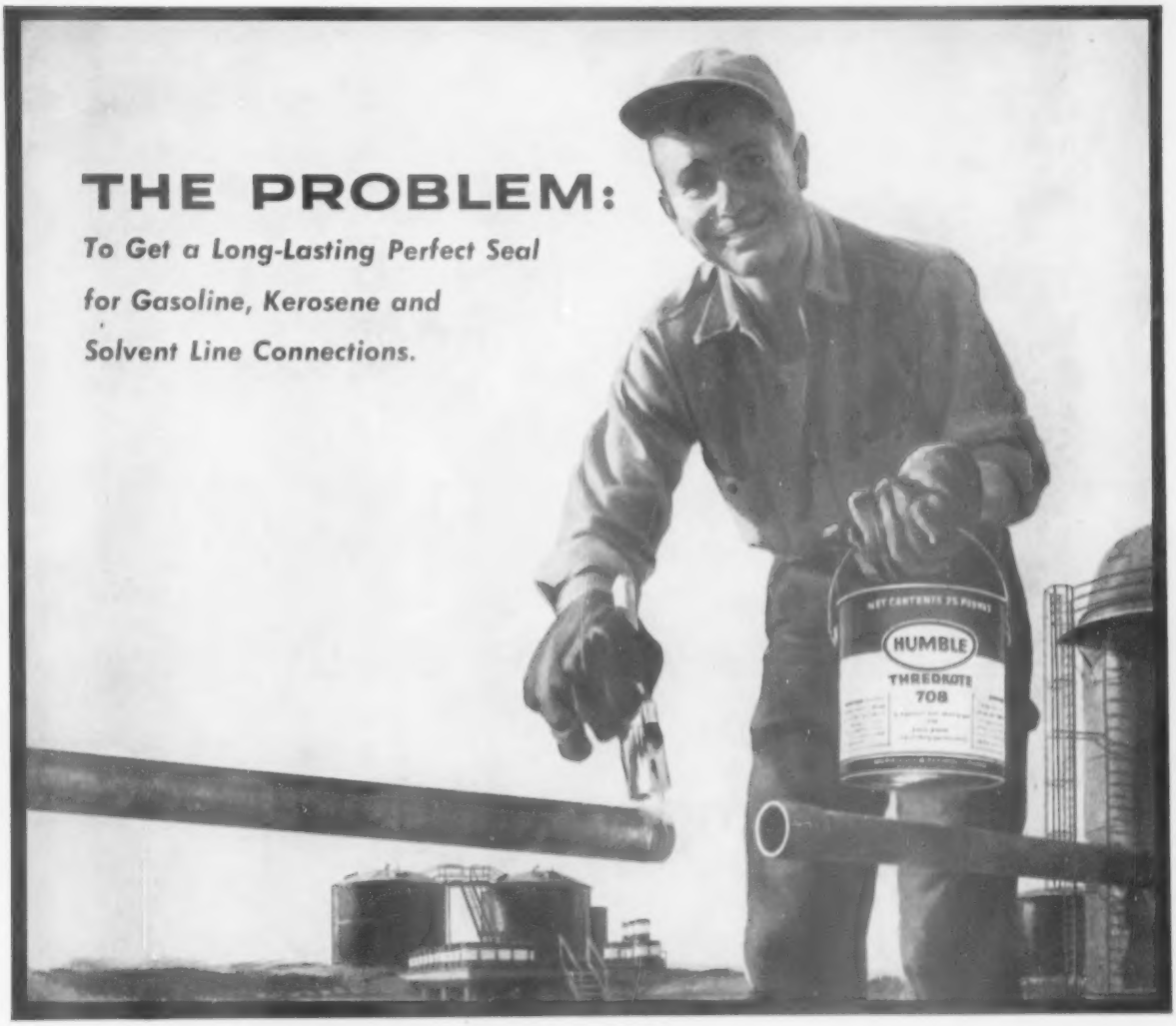
Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

313 WILSON, SO. NORWALK, CONN.



THE SOLUTION: *Use Humble's* Thredkote 708

on Threaded Connections.

Thredkote 708 has a special base containing dispersed synthetic fillers that produce a seal insoluble in either petroleum or water. It gives you a lasting perfect seal at threaded connections, but allows the joint to be broken easily without damage to the thread.

Thredkote 708 is one of a complete line of quality thread compounds. There's one for practically every type of threaded connection.

For more information on *Thredkote*, see your nearest Humble wholesale plant in Texas and New Mexico, or write or phone: Technical Service, Sales Department, Humble Oil & Refining Company, P. O. Box 2180, Houston 1, Texas.

HUMBLE

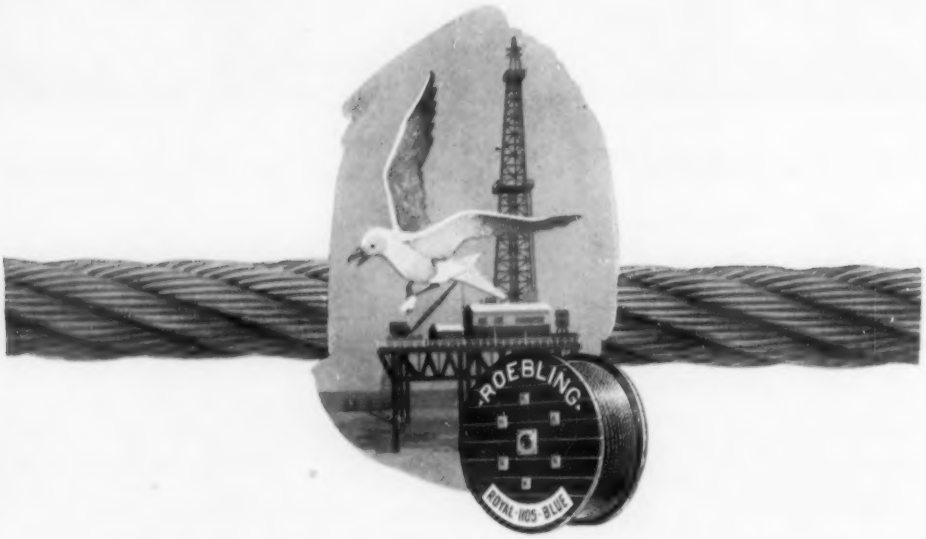
strong

Roebling's finest!

Royal Blue's extra strength

vastly increases...even doubles...

wire rope service life



John A. Roebling's Sons Corporation, Trenton 2, N. J., Subsidiary of The Colorado Fuel and Iron Corporation BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 2340 GLENDALE-MILFORD RD., EVENDALE • CLEVELAND, 13225 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • PITTSBURGH, 1723 HENRY W. OLIVER BLDG. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 321 N. CHEYENNE ST. • EXPORT SALES OFFICE, 19 RECTOR ST., NEW YORK 6.

COMMERCIAL air transportation is one of the fastest-growing industries in America. But it should never be forgotten that with almost every new stride this industry has taken, the petroleum industry has had to be one jump ahead . . . has had to be ready with the lubricants and fuels to fit the job. We of The Texas Company are proud that our association with this vital industry has been such a long and successful one. In fact . . .

For more than 20 years, more scheduled revenue airline miles in the U. S. have been flown with Texaco Aircraft Engine Oil than with all other brands combined.

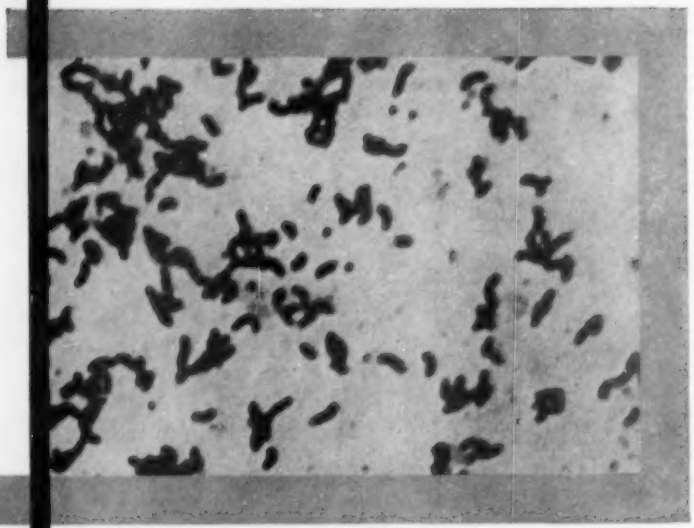
The Texas Company

TEXACO

Is your water flood

DEBILITATED by DESULFOVIBRIOS DEPREDATIONS?

Desulfovibrios are more easily described as the sulfate reducing bacteria. No matter what they're called, they spell trouble for any water-flood or water-disposal operation. Their growth leads to the formation of insoluble sulfides which eventually will reduce the porosity of the formations. This loss of porosity always reduces operating efficiency, and frequently necessitates expensive cleaning jobs, or even injection well abandonment. The best safeguard against bacteria troubles is an effective bactericide.



MORE AND MORE OPERATORS NOW RELY ON

X-CIDE

X-CIDE is a water-soluble, liquid organic inhibitor. It prevents the growth of anaerobic and aerobic bacteria micro-organisms in either fresh or salt water systems. It is particularly effective against the sulfate reducing organisms which change sulfates to corrosive hydrogen sulfide. In addition, X-Cide is an effective corrosion preventive, plating out on metal surfaces to form a tough, impervious film which resists all forms of corrosive attack.

The use of X-Cide bactericides and Kontol corrosion inhibitors is standard operating practice with many leading water-flood operators. Your Tretolite service engineer will give you all the facts. Why not call him today?

Chemicals and Services for the Petroleum Industry

Demulsifying • Desalting • Water De-Oiling
Corrosion Inhibiting • Paraffin Removal
Scale Prevention • Production Stimulation

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

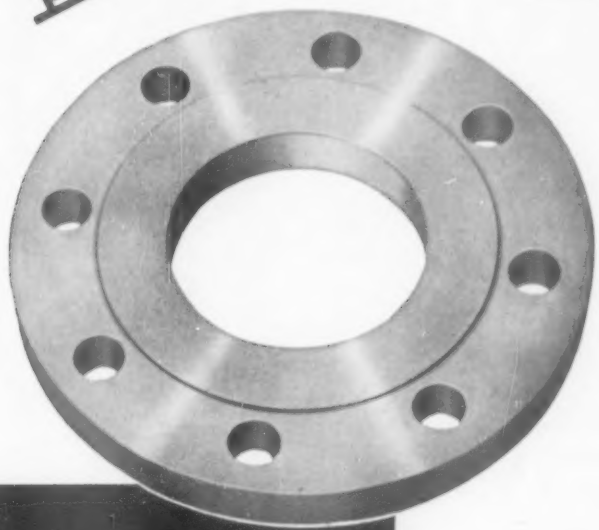
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

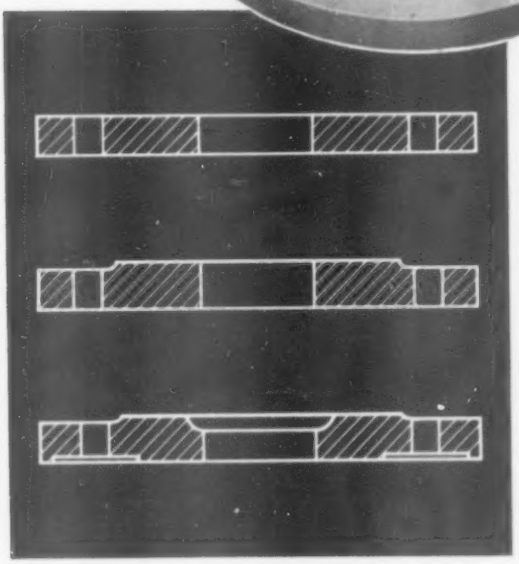
X 5622

MILD STEEL

PLATE TYPE

flanges





Harveys are able to supply, from stock, a full range of Standard Plate Type Mild Steel Flanges for pressures ranging from 51 p.s.i. to 450 p.s.i.

Non-standard Flanges manufactured to specification.

For details of standard dimensions please write for List No. OG 905.

Harvey

G. A. HARVEY & CO. (LONDON) LTD.

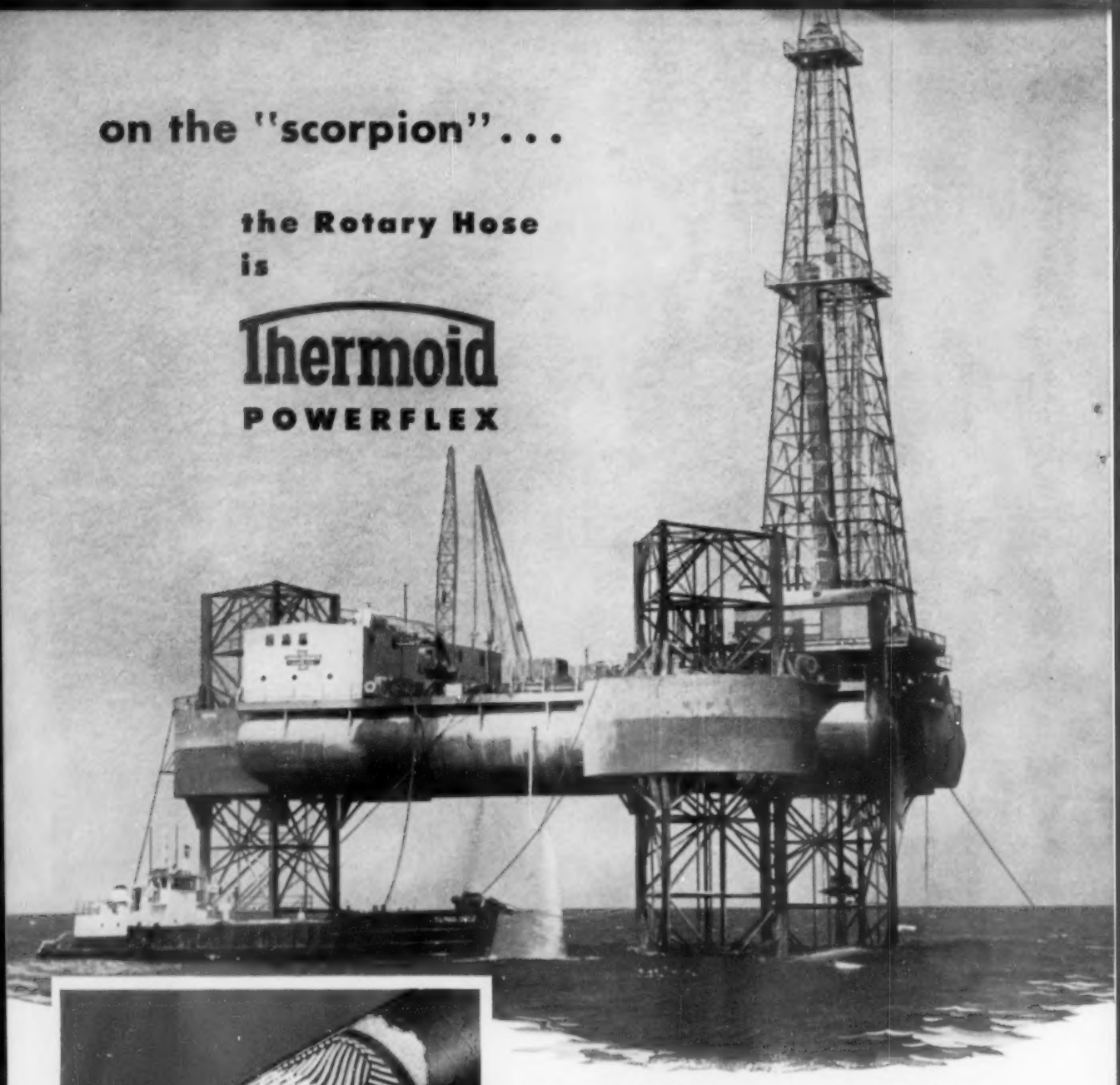
Woolwich Road, London, S.E.7, England

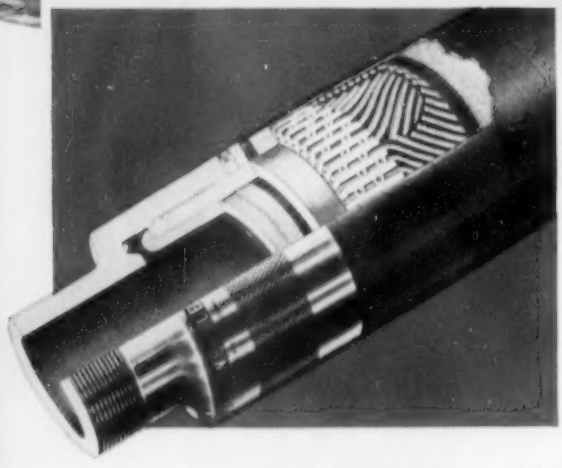
Cables: "Cheaper, London"

on the "scorpion"...

the Rotary Hose is

Thermoid
POWERFLEX



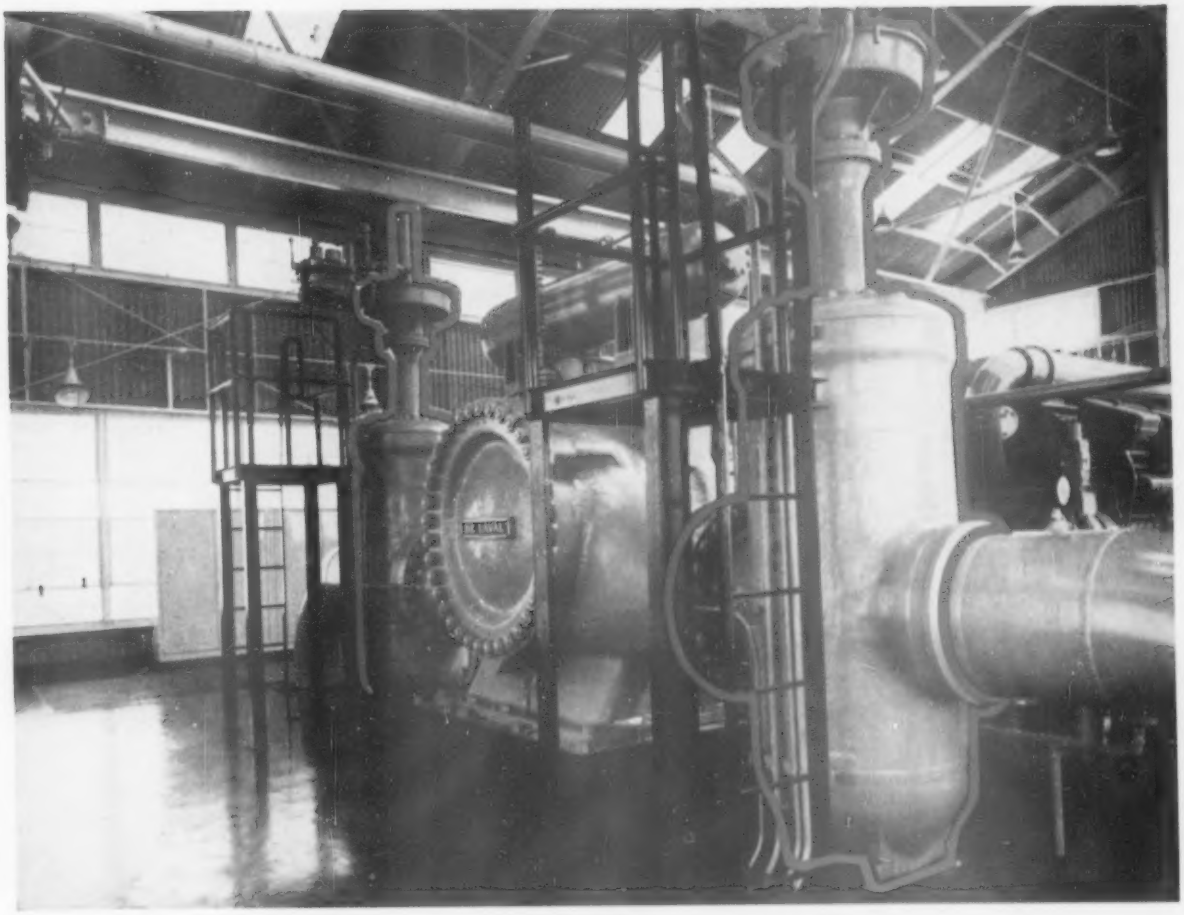


The patented full flow coupling at the left is just one reason why the Scorpion is equipped with Thermoid Powerflex Rotary Hose. It's an integral part of the cable assembly—cannot leak or pull off. The cable itself is made up of *33 miles of high tensile steel-wire* wrapped and counter wrapped. And the tube and cover of Powerflex Hose are made with oil and abrasion resistant Neoprene, reinforced with impregnated multi-ply woven fabric.

You'll also find Thermoid Suction and Discharge Hose and Thermoid Multi-V Belts "aboard" the Scorpion for the same reason—superior quality construction. Order Thermoid Oil Field Products from your nearest supply store or Thermoid warehouse.

Thermoid

THERMOID COMPANY, TRENTON, NEW JERSEY, NEPHI, UTAH
Warehouses: HOUSTON, OKLAHOMA CITY, ST. LOUIS, CASPER, LOS ANGELES



W-K-M VALVES *of course*

In Transco's new centrifugal compressor station

There's no change in the shape of the stream—no loss of pressure as gas flows through the W-K-M Valves on either side of the Centrifugal Compressor in Transco's pioneer station of this type. Opening through the valve is the same I.D. as the pipe — the bore is smooth. There are no restrictions — no projections to set up turbulence, to cause pressure drop. The parallel expanding gate of the W-K-M Valve provides a positive shut-off.

For maximum performance with minimum maintenance on pipelines anywhere, any size, it's always wise to specify W-K-M through-conduit, parallel expanding gate valves. Ask your W-K-M representative or write for new Pipeline Valve Catalog 300.

5656

W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF QCf INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS • MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

MANUFACTURERS OF

W-K-M THROUGH-CONDUIT GATE VALVES

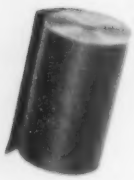
QCf LUBRICATED PLUG VALVES

KEY RETURN BENDS AND FITTINGS

Cut maintenance costs. . . increase pipe life

with proven performance . . .

On job after job, pipe line men rely on these Johns-Manville Asbestos Pipe Protection Materials to fight pipe line corrosion:

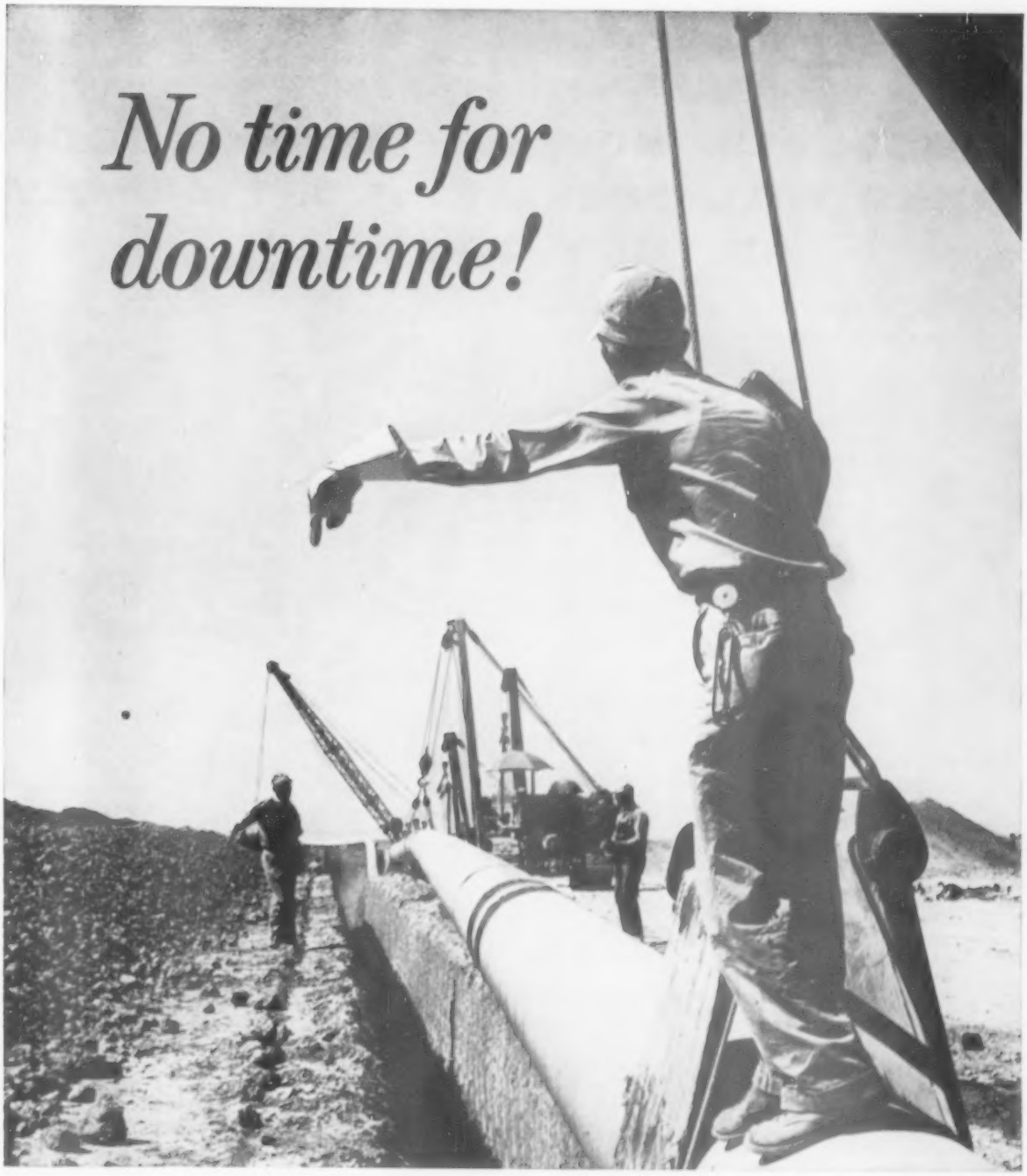


Transhield® Asbestos Felt This low-cost pipe line protecting wrapper is specially designed to increase pipe life under average soil conditions. It is reinforced with continuous glass yarns, parallel spaced on ¼" centers to give tear-free application strength. Made of coal-tar saturated asbestos, it acts as a lasting barrier to shield pipe line enamels from earth loads and soil stresses.

#15 Asbestos Pipe Line Felt—A heavy-duty material particularly suitable for severe soil conditions or where a heavier material than J-M Transhield is desired. Provides long life, toughness, flexibility, resistance to rot, decay, cracking, and impact. J-M #15 Asbestos Felt now protects more than 100,000 miles of oil and gas pipe lines. Widths 2" to 36". Rolls any length desired.

For further information about Johns-Manville Products for Pipe Line Protection, write to Johns-Manville, Box 14, New York 16, N. Y.; in Canada, Port Credit, Ontario.

Johns-Manville **PRODUCTS FOR PIPE LINE PROTECTION**



PACIFIC NORTHWEST PIPELINE CORPORATION PHOTOGRAPH

Staying on schedule is absolutely essential on a pipe line job.

That's why so many pipe line builders depend on Kaiser Steel for quality pipe to meet API specifications—*delivered as scheduled.*

Next time you are ordering line pipe, specify Kaiser Steel Line Pipe. Rely on Kaiser Steel quality and service to add dollars to your operating profits.

Kaiser Steel

Steel Mill Products: slotes • hot rolled strip and sheet • cold rolled strip and sheet • tin plate • continuous weld pipe • electric weld pipe • alloy and carbon bars • bar shapes • structural shapes semi-finished steels • pig iron • ingot molds • coke by-products • **Fabricating Division:** steel fabrication for construction, aircraft, missile and other industries • expanded fusion weld pipe reinforced concrete pipe • tanks • For specifications, write **KAISER STEEL CORPORATION** • Los Angeles • Oakland • Seattle • Portland • Phoenix • Denver • Tulsa • New York

exhaustive tests prove:

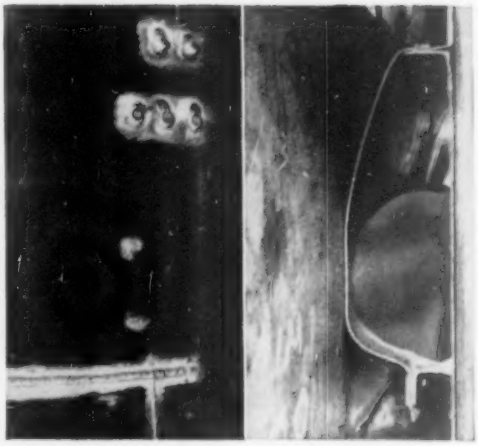
36 YEARS FROM TODAY

TUBESEALS* NOW IN FLOATING ROOF TANKS WILL OPERATE AS EFFICIENTLY AS THEY DO TODAY!

WE DOUBT this can be claimed for any other floating roof seal!

To determine the efficient life-expectancy of the Hammond Tubeseal in service, tests were made under the worst possible conditions to which a floating roof seal can be subjected. The Tubeseal was moved across very rough rivet heads, erection burrs and abrasive weld surfaces, for a total travel of 70,000 feet. This is equivalent to a normal wear of *more than 36 years in actual service.* Moreover, as the tests were run dry, there was the added disadvantage of the absence of lubricating effect normally created by wetted surfaces. Upon completion of these rigorous tests, the scuff band had only worn through the ribs and had barely penetrated through the material, leaving two-thirds of the stock intact; proof that the Tubeseal is unimpaired after traveling 70,000 feet.

The 36 year life-expectancy of a Hammond Tubeseal assumes no mechanical accident and is arrived at in the following manner: Each year a floating roof, in normal service, makes about 48 trips to and from top and bottom of tank. The roof of a 40 foot tank, therefore, will travel 1920 feet per year. Assuming 1920 feet of travel per year (based upon full depth of travel) and applying our accelerated wear test, the Tubeseal will be serviceable for at least 36 years 5½ months.



THE TUBESEAL TEST:

total travel	70,000 feet
travel over vertical weld	46,400 feet (on same line)
Horizontal welded seam crossed	21,200 times
Flat head rivets crossed	63,600 times

CONDITION OF TUBESEAL AFTER TEST: Scuff band had worn through ribs and had barely penetrated into the main material, leaving ⅔ of stock intact.

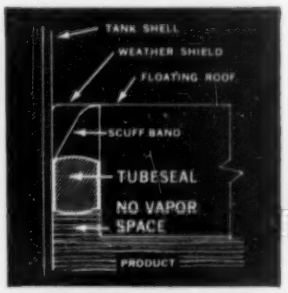
Tests were conducted dry with no aid of lubricant normally resulting from stored product.

Photos show projections used for test. Included are 16" of ⅜" horizontal weld—24" of sharp, irregular vertical weld—2 erection burrs—3 ¾" flat head rivets and 2 ¾" cone head rivets.

THE HAMMOND TUBESEAL
is the most efficient and positive seal known.

it features:

no moving parts
no mechanical maintenance
climate proof
non-corrodible
can operate to bottom of tank or above the top
no vapor space below the seal
entire circumference has tight seal under pressure at all times
longer working life expectancy



NO ROOM FOR VAPORS
NO EVAPORATION
NO CORROSION

patented* ***Write for bulletin TS*

HAMMOND TUBESEAL — THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices:

BOSTON 10, MASS. • NEW YORK 20, N. Y. • CINCINNATI 2, OHIO • CHICAGO 3, ILL. • WARREN, PA. BRISTOL, PA. • ARLINGTON, VA. • GREENVILLE, S. C. • BIRMINGHAM, ALA. • SAGINAW, MICH. SAPULPA, OKLA. • PROVO, UTAH • CASPER, WYO. • LOS ANGELES 57, CALIF. • HAVANA • MEXICO CITY "TIPSA," BUENOS AIRES • CAIRO, EGYPT • PORT-AU-PRINCE, HAITI • LIMA, PERU

Licensees: CALIFORNIA, CANADA, ENGLAND, BELGIUM, GERMANY, ITALY, FRANCE, JAPAN

Rugged Chicago Pneumatic Three Cone Rock Bits are designed to afford deep penetrating action with every turn of the drill stem. Their fast cutting speed enables you to drill more feet a day. They're available in seven different types from soft to exceedingly hard and abrasive formations. *Oil Tool Division, Chicago Pneumatic Tool Company, 5000 U. S. Highway 81 South, Fort Worth, Texas.*

Chicago Pneumatic

GENERAL OFFICES: 8 East 44th Street, New York 17, N. Y.
IN CANADA: 10103 81st Ave., So. Edmonton, Alberta, Canada
IN MEXICO: D.R. Rosas Morena No. 41, Mexico City, D. F., Mexico
PETROLEUM MACHINERY CORPORATION: 30 Rockefeller Plaza, New York 20, N. Y. (Export Agent, exclusive of Mexico and Canada)

EQUIPMENT MEN . . . in the News

Oilwell Appoints Craig, Rudd, Estes, and Higgins

The appointments of Robert C. Craig as assistant district manager at Denver, Colo.; James H. Rudd as the Houma, La., field representative; Edwin D. Estes as field representative at Carmi, Ill.; and Robert L. Higgins as field engineer at Edmonton, Alta., have been announced by Oil Well Supply Division of U. S. Steel Corp.

Craig, who joined Oilwell in 1945, has served as field representative at Artesia, Colo.; manager of the Worland, Wyo., store; district representative at Casper, Wyo., and at Billings, Mont.; district engineer, refinery and pipeline sales, at Worland; and city representative at Casper and Denver.

Rudd was employed by Oilwell in 1955 at Houma. Estes joined the division in 1948. He worked at the Centralia and Salem, Ill., stores, Grandville, Mich., and Carmi.

G & H and Gulfport Officials Attend Marlin Launching

Executives of G & H Towing Co., Inc., and Gulfport Shipbuilding Corp. gathered in Port Arthur, Tex., recently for the launching ceremony of the new 1,250 diesel horsepower all-steel tug Marlin, being built for G & H by Gulfport. The new tug is expected to join the G & H harbor and offshore towing operations in September.

Shown are Doug Haden, son of Cecil R. Haden; J. T. Westmoreland, G & H offshore oil-industry service representative; W. R. (Bill) Orange, G & H port engineer; Erie D. Harlan, G & H comptroller and administrative officer; Capt. John G. Leech, director of marine operations for G & H; Capt. H. O. Weatherbee, G & H executive vice president; and Cecil R. Haden, president of G & H Towing Co., Inc. G & H operates a fleet of 19 tugs from bases in Houston, Galveston, and Corpus Christi.

Leschen Names Ewerhardt And Muse to Sales Posts

Karl F. Ewerhardt has been appointed to the newly created position of assistant general sales manager of Leschen Wire Rope Division of H. K. Porter Co., Inc., and Maurice M. Muse has been named district sales representative for eastern Kentucky and Tennessee and northern Alabama.

Ewerhardt, previously advertising manager of the division, will expand his activities from advertising and sales promotion to general sales office activities.

Muse has had 14 years experience selling wire rope in the same territory, part with American Chain & Cable Co. and part with McCarthy, Jones & Woodard, distributors.

Electro-Motive Officials Visit George Engine Co.

A group of officials of the Electro-Motive Division of General Motors Corp. recently visited George Engine Co., Inc., of Harvey, La. George Engine Co. is General Motors' petroleum-industry dealer for diesel electric oil-field drilling equipment and holds the exclusive franchise for GM marine, industrial, and oil-field engines in its territory.

During their visit, the officials were conducted on a tour of the Harvey plant. Pictured in front of the George Engine plant are: B. E. McMichael, service manager for George Engine; Fred Batty, general service manager for Electro-Motive Division; R. J. Naquin, parts manager of George Engine; George S. Frierson, president of George Engine; Frank A. M. Williams, vice president and comptroller of George Engine; H. F. Colby, sales manager of George Engine; Frank Doonan, sales manager for Electro-Motive, who is in charge of the newly opened Morgan City, La., office; Don Queeney, industrial sales manager of Electro-Motive Division; and H. P. Gustavson, manager of petroleum industry sales for Electro-Motive.

Maloney-Crawford Purchased by Byllesby

Maloney-Crawford Tank & Manufacturing Co. of Tulsa, pioneer manufacturers of bolted and welded steel tanks, oil and gas separators, emulsion treaters, dehydration units and pressure vessels, has been purchased by H. M. Byllesby & Co. of Chicago.

This announcement was made jointly by S. P. Wallace, president of Maloney-Crawford, and J. H. Briggs, president of Byllesby & Co. Management, personnel, and policies of Maloney-Crawford will be maintained, it was stated.

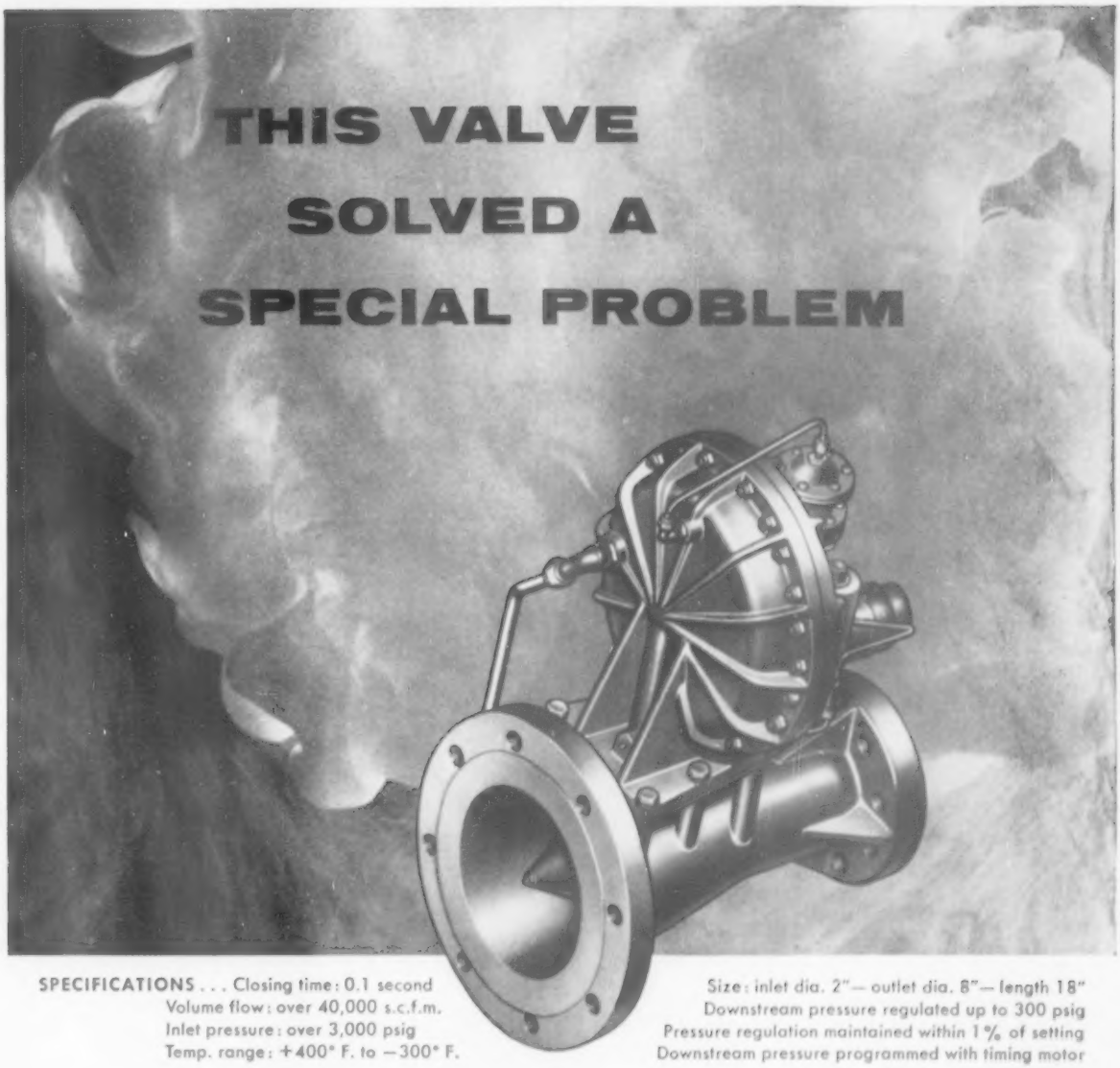
Talbert Appointed Sales Manager for Mission, Ltd.

W. C. TALBERT

W. C. (Bill) Talbert has been appointed sales manager for Mission Manufacturing Co., Ltd., with headquarters in London. The announcement was made by Richard White, executive vice president of Mission Manufacturing Co. at Houston.

Talbert has been assistant export sales manager of the Houston concern with headquarters in New York City. Previous to that time, he was with the company in Venezuela as a field

THIS VALVE SOLVED A SPECIAL PROBLEM



SPECIFICATIONS . . . Closing time: 0.1 second
Volume flow: over 40,000 s.c.f.m.
Inlet pressure: over 3,000 psig
Temp. range: +400° F. to −300° F.

Size: inlet dia. 2"— outlet dia. 8"— length 18"
Downstream pressure regulated up to 300 psig
Pressure regulation maintained within 1% of setting
Downstream pressure programmed with timing motor

Fifteen years of AiResearch experience in engineering and fabrication of valves for special applications went into this design.

As you can see from its specifications, the valve shown does a job that has never been done before. This type of valve problem is increasing, particularly in petroleum, chemical, rocketry, atomic energy and research applications.

AiResearch has designed and manufactured thousands of valves to meet special requirements. We are prepared to solve valve problems which include the handling of liquid nitrogen, liquid oxygen and pressurized helium . . . which require operation without fail under the most rigorous extremes of heat, cold and other environmental conditions.

If you have a problem involving specialized valves, we invite you to contact us. Our engineers will analyze your problem with you and recommend a solution.

THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Boulevard, Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS

Better than good—this pair is the best!

NO-GALL or LO-TORK Compounds give threads on tool joints and drill collars the best protection money can buy. They do this by minimizing friction—maximizing gall resistance. They spread easily, uniformly—never gum up or squeeze out. They lubricate without freezing—permit fast break-out on string after string of drill pipe.

It's just sound economics to insist on the best compound you can buy. It means longer life for tool joints, less down time, money saved. Next job insist on the BEST—insist on either WECO NO-GALL or LO-TORK Compounds. Available at supply stores everywhere.

U-10-55

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

WECO

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

service engineer. Talbert joined Mission as an engineer in 1946.

Anchor Petroleum Promotes Felts, Moffett, Foley

F. R. FOLEY

Three men have been promoted to positions in the asphalt and refined-oil division of Anchor Petroleum Co., Tulsa, L. E. Riffe, vice president in charge of the division, has announced. Ray L. Felts has been named manager of refined-oil sales and office manager. He formerly was office manager of the firm.

R. L. FELTS

D. L. MOFFETT

Dean L. Moffett was advanced to manager of road asphalt sales. Formerly he was asphalt sales engineer.

Floyd R. Foley will manage the firm's oil-well-treating products department.

Two New Companies Organized By LeBus

Announcement of the liquidation of LeBus Rotary Tool Works and the organization of two new LeBus companies has been made in a joint statement by F. L. LeBus and F. L. LeBus, Jr.

LeBus International Engineers, with F. L. LeBus, Jr., as manager, will be one of the new LeBus corporations. The other will be LeBus Manufacturing Co. and will be a subsidiary of American Hoist & Derrick Co. of St. Paul, Minn., which has acquired the present LeBus plant and facilities for the manufacture of LeBus dropped forged truck tools and wire-line accessories.

LeBus International Engineers, Inc. will build a new plant to expand the operation of its wire-line spooling services, telescope drill joints, fishing tools, and other oil-field tools planned for the immediate future. An expansion program also is planned by American Hoist & Derrick for its LeBus Manufacturing Co.

LeBus International Engineers will retain all machinery, inventory, management, engineering and operating

AVONDALE
MARINE WAYS, INC.

NEW ORLEANS

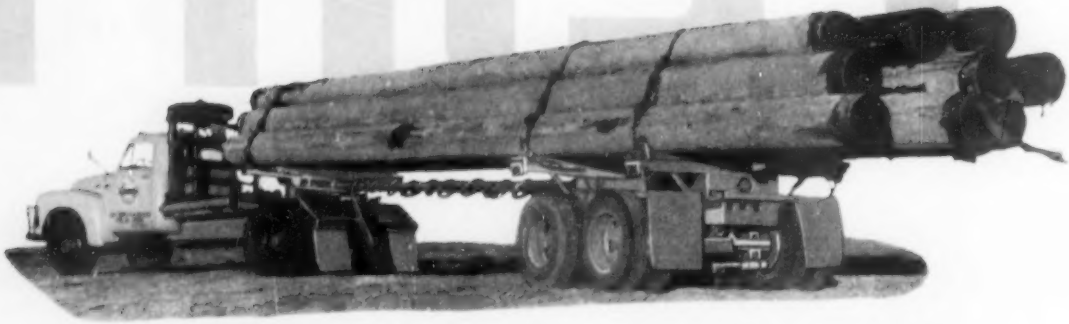
. . . REFLECTIONS ON THE FUTURE

This Avondale-built towboat is but one of the many Avondale products casting the image of its reflection upon U. S. and world industry. Avondale products have spread our name across the nation and the globe in such a fashion that today they are known as symbols of quality in their respective fields: marine shipbuilding and repair; stainless steel propeller design and manufacture; the manufacture of porcelain enamel service stations; engineering; research; specialized steel fabrication; complete foundry service and specialization in offshore oil facilities.

from the heart of the South, serving the Nation and the World

SINCE

1916..



IN TRAILER MANUFACTURING

Being first with the best is traditional with Spencer-Safford Loadcraft. Since 1916 when Fred Spencer built the first pole trailer for the oil industry there have been many imitations of the products manufactured by the Spencer organization — for originality and quality are always imitated. Now in 1956 the name Spencer-Safford is accepted by the many industries using Loadcraft products as being synonymous with quality and originality. To continue to be the leader in product and service is the Loadcraft pledge.

Spencer-Safford LOADCRAFT INC.

PHONE 1082 AUGUSTA, KANSAS

SINCE 1916

personnel connected with drum grooving and wire-line spooling systems and oil-tool manufacturing.

LeBus Manufacturing Co., with headquarters at Longview, Tex., will have as its manager John McEvoy, who has been the manager of American Hoist's South Kearny plant for many years.

Clark Named Assistant Division Manager by Welex

W. B. CLARK

W. B. Clark has been promoted from district manager to assistant division manager of the Oklahoma division for Welex Jet Services, Inc., according to Jack Vaughan, vice president in charge of sales. Clark has been with Welex 7 years, having served as rigger, shooter, assistant district manager, and district manager.

Schuyler Appoints Rawson As Sales Representative

Schuyler Manufacturing Corp. of North Arlington, N. J., manufacturers of the complete line of Schuylernit entrainment separators (mist eliminators) has announced the appointment of Rawson & Co. as its sales representative.

With headquarters in Houston, Rawson & Co. will handle the complete sales and service for Schuyler's petroleum and chemical equipment.

Baker Named Coordinator Of Sales for Cameron

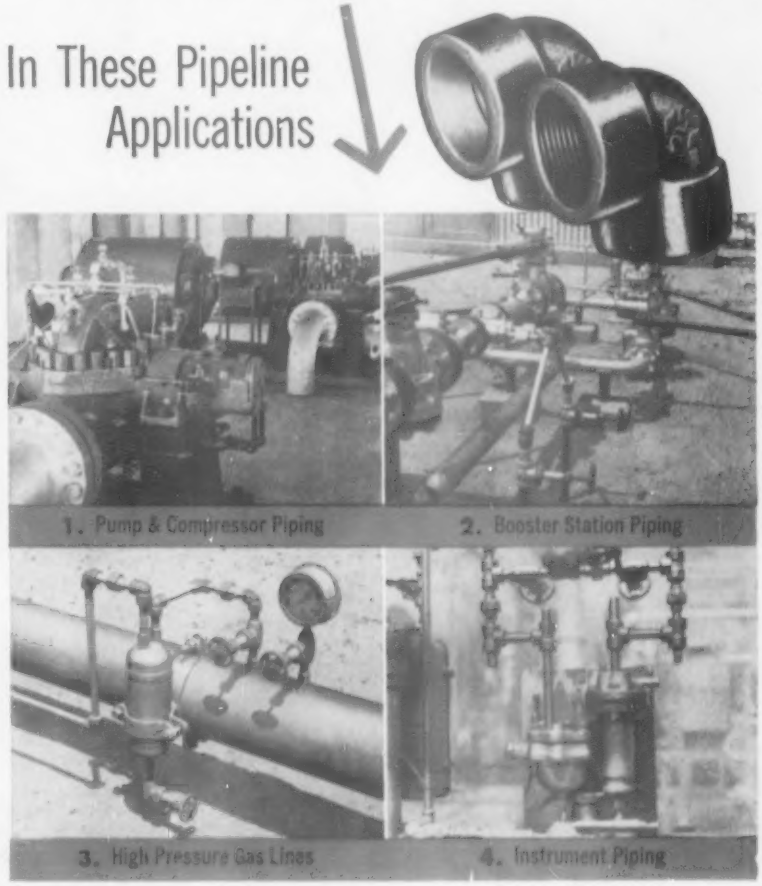
I. M. BAKER

I. M. Baker has been named coordinator of sales for the international division of Cameron Iron Works by John Grubb, manager of the company's international division. In his new position, Baker will supervise all Cameron sales outside of the United States. His headquarters will be in Houston.

Cameron's international division directs all manufacturing and sales outside the continental United States. In addition to a manufacturing plant at Leeds, England, offices are maintained in New York City, Calgary, London, Mexico City, as well as complete warehouse facilities in Edmonton, Alta.

For SAFE, TIGHT Connections, Use
WATSON-STILLMAN
FORGED STEEL FITTINGS...

In These Pipeline Applications



Watson-Stillman Forged Steel Fittings provide safe, tight connections for your small diameter, high pressure piping ... give you full protection against costly shutdown. Drop-forged of high strength steel for maximum resistance to pressure, shock and vibration, W-S fittings can be obtained in both screw-end and socket-welding types, sizes ⅛" to 4" I.P.S.

Fittings are available in carbon steel, stainless steels and alloy steels to meet a wide range of service conditions. Screw-end type in 2000, 3000 and 6000 lb. WOG class; socket-welding type for schedule 40, 80, 160 and XX pipe. We also manufacture a line of 150 lb. stainless steel fittings for corrosive, low pressure service.

Send today for our up-to-date technical catalogs.

Sold Through Leading Distributors

W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.
Roselle, New Jersey

"Phil, what will we have to do to get dry gas?"

"There's just one thing to do! Call in Pritchard."

"Why, Pritchard?"

"Two reasons. First, designing and building natural gas dehydration plants is one of Pritchard's specialties. Second, when Pritchard says 'dry', they mean *dry*."

"Haven't we worked with Pritchard before?"

"Yes, and they certainly surpassed our expectations. When they assume the responsibility for a gas dehydration project, you can be sure that the job will get done faster and you will get into production quicker."

"Looks like you have the answer to our problem, Phil. Now there's just one thing to do."

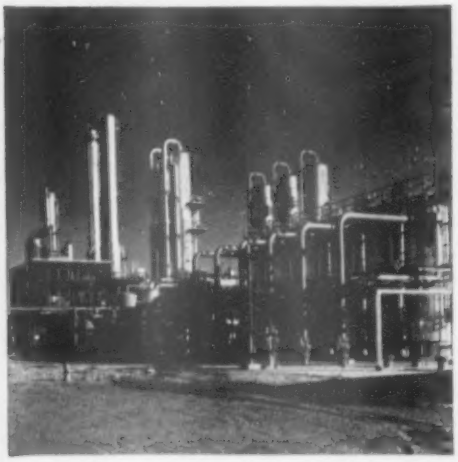
"What's that?"

"Get on the phone and call Pritchard!"

J. F. PRITCHARD & CO.
4625 Roanoke Parkway, Kansas City 12, Mo.

"Phil, what will we have to do to get dry gas?"

Pritchard experience in building dehydration plants is your assurance of success!



The gas industry has grown to respect Pritchard for the engineering and construction of dehydration plants.

When Pritchard designers say "dry", they mean *dry*.

And they are capable of following up with construction that stands the test . . . and you can be assured of greater production for your operation.

Let Pritchard solve your gas treating problems. Consult Pritchard on your next dehydration plant!

INDUSTRY'S PARTNER FOR PROGRESS

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SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

BOSTON, CHICAGO, BUFFALO, HOUSTON, NEW YORK, PITTSBURGH

Sales and services also are maintained in the active oil areas of the world.

Baker has been a member of Cameron's sales staff for the past 16 years, and prior to this recent promotion, was division manager in charge of Latin American sales.

Schlueter Fellowship Award Winner Announced

W. A. Schlueter, former president and founder of the Refinery Supply Co., has announced that Joe Merl Nelson from Claude, Tex., has been selected as the recipient of the sixth annual $1,000 William Earl Schlueter, Jr. fellowship award in the school of chemical engineering, University of Oklahoma, for the academic year 1956-57.

Nelson attended Hardin-Simmons University until 1950. He transferred to the University of Oklahoma where he received his bachelor's degree in February 1956. He is now working on his M.S. in chemical engineering.

Delta Appoints Sales Vice President, Area Sales Mgr.

The appointment of William V. Rathbone as vice president in charge of sales for Delta Tank Manufacturing Co., Inc.

W. V. RATHBONE

B. W. BOURNE

has been announced by Kenneth H. Gayle, Jr., president. Naming of B. W. Bourne as Houston area sales manager has been announced by Ross B. Baze, vice president in charge of sales for Delta Tank's oil-field equipment division.

Rathbone formerly was with Standard Oil Co. of New Jersey and later served for 10 years with Parkersburg Rig & Reel Co., culminating as executive vice president.

Delta, a wholly owned subsidiary of General Gas Corp. of Baton Rouge, operates plants in Baton Rouge, Macon, Ga., and Beardstown, Ill.

Schutte & Koerting Names East Texas Representative

W. John Schwing, Houston, has been appointed Schutte & Koerting Co.'s representative for the eastern half of Texas.

Schwing, who was formerly asso-

"SCOT" FORGED SEAMLESS RING GASKETS

MINIMUM HARDNESS

For ring groove flanges forged from reforging billets in all stainless, chrome, monel, copper, extra low carbon steel. Machined in all A.P.I.-A.S.A., special sizes, and other types.

Available through your supply store.

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REDDY KILOWATT SAYS —

We cordially invite you to call on us for information on costs and availability of electric service in Oklahoma and for consultation on any electrical problems you may have. Phone or write Public Service Company of Oklahoma, B. F. Thompson, Sales Department, Mezzanine, 6th & Main, Tulsa 2, Oklahoma.

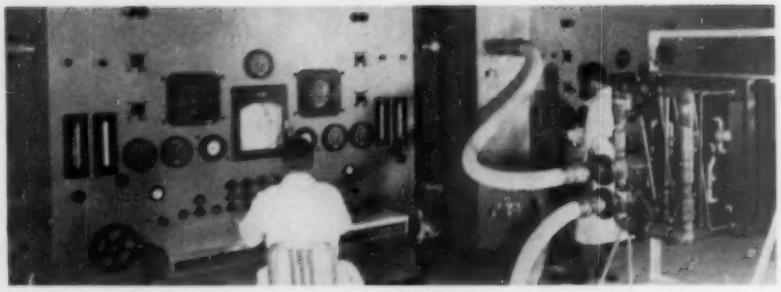
Dependable electric power for all branches of the oil business!

ciated with the company, has had 15 years' experience in engineering, design, and equipment testing.

Sims Joins Refinery Sales For Catalytic Construction

Willis F. Sims has joined Catalytic Construction Co. as refinery sales representative for the Southwest area, with headquarters in Tulsa, according to T. E. Webster, president.

Sims was formerly refinery manager at Wichita Falls, Tex., for Panhandle Oil Corp. and was with Blaw-Knox Co. before joining Catalytic.



Fischer & Porter Dedicates Fluids Calibration Lab

Master calibration stands in new Allan P. Colburn Memorial Flow Laboratory. Unit at right is calibrating a multistage flow test meter. Explosionproof manometers are on wall above stands.

Dedication ceremonies for Fischer & Porter Co.'s Allan P. Colburn Memorial Flow Laboratory were held recently. Included in the program was the unveiling of a plaque commemorating Colburn's contributions in the field of variable-area flow metering. Short talks were given by Kermit Fischer, president of Fischer & Porter; Dr. R. L. Pigford, chairman of the department of chemical engineering, University of Delaware; and Dr. Samuel E. Pond, of Pratt & Whitney Aircraft.

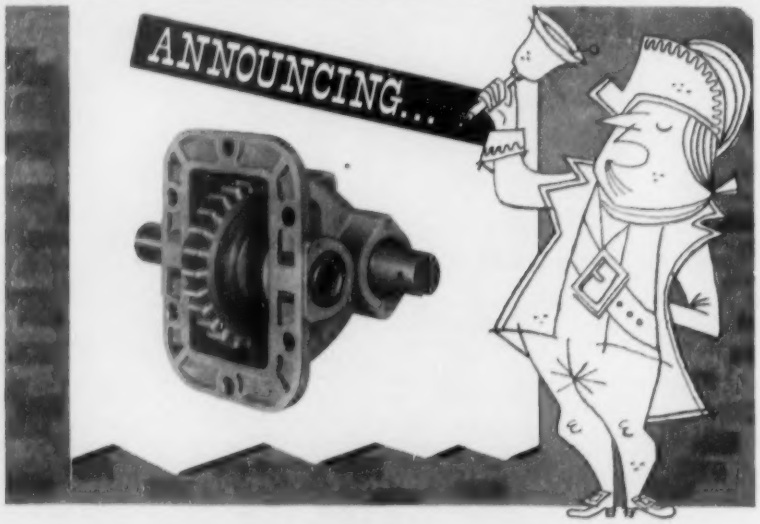
The laboratory is one of the most completely equipped hydraulic test facilities in this country. It has been specifically designed for the calibration of flow meters measuring hazardous or volatile fluids and is engineered for safety, accuracy and flexibility. The facility is equipped to conduct calibrations on both a production and a research basis. At present there are two dual calibration units utilizing the standpipe-weigh-stand principle, with provisions for a third unit to be added at a later date.

Associated to Commence Office-Warehouse Building

Associated Oil Field Rentals has announced plans to open a branch rental yard in Morgan City, La., to supply both inland and offshore drilling equipment. The new yard, the eleventh branch of the Houston-based tool-rental firm, is expected to be in operation by October.

Jim Taylor of Morgan City will head the new yard, under the direction of C. K. Carruthers, Associated's Gulf Coast division manager. Wood George is vice president and general manager of the rental firm.

Associated will construct a 5,760-sq.-ft. building to house office and warehouse facilities on a 100,000-sq.-ft. property which is accessible for truck or water deliveries. A complete line of rental tools and equipment ranging from 20-in. blowout preventers to slim-hole drill pipe will be carried.



NEW SINGLE SPEED . . . ALUMINUM HOUSING . . . POWER TAKE-OFF

IT'S A TULSA® . . . ALWAYS BEST!

Important features that make this new TULSA power take-off outstanding:

- Die-cast aluminum housing . . . extremely lightweight
- Output shaft rotates on two needle bearings
- Three output shaft sizes
- Cable or lever control
- Low priced

This new power take-off for all medium duty work offers all the advantages of the complete TULSA line—highest quality, nationwide distribution and service.

Tulsa Winch
TULSA, OKLAHOMA DIVISION OF VICKERS Inc.

Parkhill Names Two as Administrative Assistants

Howard C. Gooden and M. J. (Jack) Mackie have been named to administrative-assistant positions newly created by Parkhill Truck Co., Tulsa, it has been announced by Kenneth Owen, Parkhill president, and Trap Briscoe, vice president.

Gooden, formerly secretary and manager of Mid-States Equipment of Denver, has been named administrative assistant, with duties and responsibilities primarily in public relations and job

H. C. GOODEN

M. J. MACKIE

development. His experience includes several years in the pipe-hauling and stringing business and the pipeline-construction contracting business.

Mackie, superintendent and projects manager for Parkhill for several years, has been named administrative assistant, serving chiefly in a liaison capacity in the field.

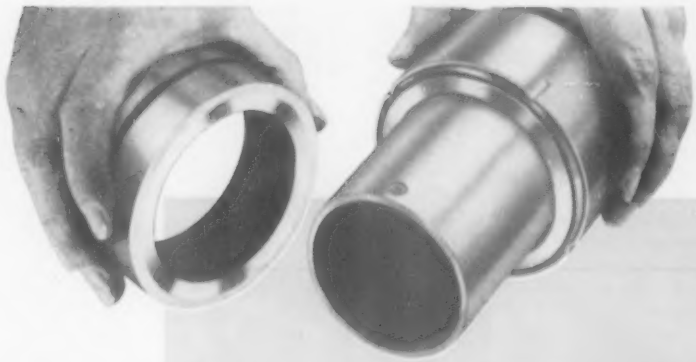
Christensen Organizes New Gulf Coast Division

Christensen Diamond Products Co. has established a new Gulf Coast division with offices in Houston. The division, formerly part of the Mid-Continent division of the company, is headed by C. Ray Hudson.

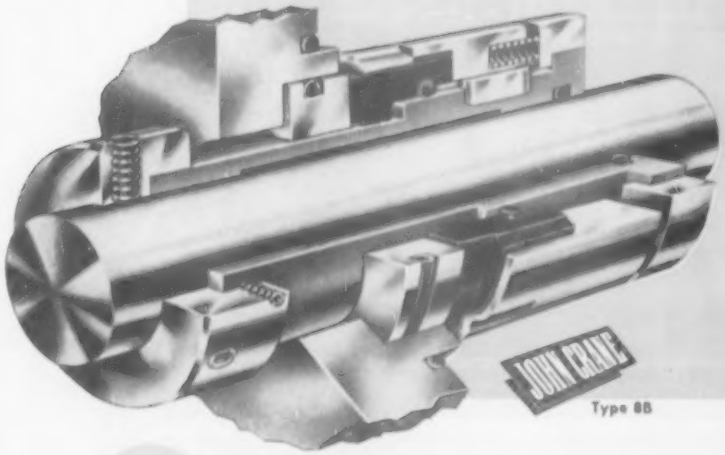
The division will consist of district offices in Houston, Shreveport, and Lafayette, La. Robert T. Barron will head the Shreveport district office. Robert J. Dyar the Houston district, and A. R. Adams the district office in Lafayette. Percy Tinsley has been appointed special representative for the Gulf Coast area and will make his offices in Lafayette.

The company also named Claude Cox, Jr., as the new Mid-Continent division manager with headquarters in Midland. Cox will direct the activities of the Hobbs, N. M., district office headed by Jack Compton; the Oklahoma City district office headed by Charles McKnight; and the Midland district office under the direction of Ross Jackson.

Hudson has been with Christensen for 6 years and has spent much of this time in the Gulf Coast area where he served as district manager. Cox has



THIS IS THE SEAL USED IN 75% OF ALL RECENT PIPE LINE PUMP INSTALLATIONS



Type 8B

These Important Facts Tell Why

Reports from the field reveal that after 2½ years of continuous operation "John Crane" Type 8B Seals are still in perfect operating condition. This adds up to over 20,000 hours without shutdown!

Man-hours are being saved. The 8B is quickly installed and adjusted simply by sliding the entire unit along the shaft into position. The top casing need not be removed.

High pressure problems are eliminated. "John Crane's" exclusive hydraulically balanced construction permits handling of pressures up to 1200 psi.

The 8B comes in a full range of sizes to meet individual specifications and can be engineered to practically any on-the-job requirement.

Be sure you get "John Crane" 8B Seal performance. Contact Crane Packing Co., 6419 Oakton Street, Morton Grove, Illinois (Chicago Suburb).

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

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STEEL CORPORATION

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This emblem on fabricated steel is assurance that it has been fabricated in compliance with industry codes. The facilities and personnel to fabricate products in strict accordance to customer's specifications.

- FABRICATED REINFORCING STEEL
- STEEL WAREHOUSE DISTRIBUTORS
- FABRICATED STEEL PLATE
- FABRICATED GALVANIZED STEEL
- FABRICATED STRUCTURAL STEEL

for over 40 years

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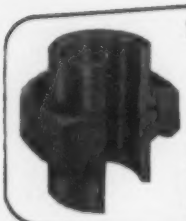
PERFECT SEAL
Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!



Standard & Double Extra Heavy UNIONS

Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS

With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS

With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

Standard & Double Extra Heavy LUG NUT UNIONS

Hammer-type for quick opening and quick closing.

Write for Catalog 56 showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
450 Mill Street • CATAWISSA, PA.

been with the company 6 years. Prior to his promotion he had served as district manager in Midland.

Land & Marine Rental Tools Firm Is Organized

OLIVE DORROH

The formation of Land & Marine Rental Tools, with headquarters in Houston's Oil & Gas Building, has been announced by Olive Dorroh of Houston, vice president and general manager of the company. President of Land & Marine Rental Tools is Leonard W. Phillips of Shreveport.

The firm's branch rental yard is in Morgan City, La., and is in charge of Jack Lubbes. Land & Marine offers a complete line of drilling, producing, and completion tools for use both on land and in offshore areas.

Albert Sklar of Shreveport is secretary-treasurer of Land & Marine. He also is vice president of Sam Sklar Associated Oils. Another vice president is Alex Singer of Tulsa. Assistant secretary-treasurer is R. H. Fleischaker, also of Tulsa. Both the latter officers are with Josaline Production Co.

Halbouty Elected to Rolo Board of Directors

R. K. (Bob) Franklin (left), founder, president, and chairman of the board of directors of Rolo Manufacturing Co., Houston, congratulates Michel T. Halbouty on his election to the board of directors at a meeting recently held in Colorado Springs, Colo. Halbouty is a petroleum engineer, geologist, and independent oil operator.

Franklin stated the election of Halbouty completes the corporation's board presently consisting of R. K. Franklin, Houston; H. Stanley Krusen of Shearson, Hammill & Co., New York; Henry W. Reed, Lehman Brothers, New York; L. R. Franklin, Rolo of Houston; W. W. Flenniken, Denver oil operator; Frank Pugsley of Baker, Botts, Andrews & Shepherd, Houston law firm; and Halbouty.

Field Sales Changes Announced by J & L Supply

R. T. BOULDIN

Robert T. Bouldin has been appointed district sales manager of the North Texas district of Jones & Laughlin Supply Division, Tulsa. Bouldin succeeds W. R. Layne who has been assigned to the southern Oklahoma district as general salesman. Bouldin will be headquartered at Wichita Falls and Layne at Ardmore. These appointments were announced by W. L. Wolfe, vice president of sales, who also named advancing store personnel.

J. S. Bastian, J. P. Hoffman, and R. L. Spenst, formerly local store managers at Casper, Wyo., Bolivar, N. Y., and Estevan, Sask., respectively, have been promoted to sales representatives. Each will continue to serve in his respective area.

H. L. Rikard, formerly manager of the firm's Sterling, Colo., store, has been made a sales representative at Casper.

William J. Parker has been advanced

FIBRE-METAL'S

WELD-PROBER

CUTS SPECIMENS FROM BUTT WELDS FOR

visual inspection

Longitudinal, transverse and oblique (a, b & c) specimens removed by Weld-Prober. Below are drawings of tension and bend test (d & e) specimens that may be machined from them.

The Weld-Prober cuts out specimens from butt welded joints so that the quality and soundness of the weld may be examined. Such specimens reveal the workmanship of the weld by exposing defects, if any, such as slag inclusions, lack of fusion, cracks or porosities. Physical and mechanical properties of the joint can also be determined by machining the specimens into tensile, bending, impact or other form of test piece.

Of particular advantage is the favorable shape of the cavity produced by the Weld-Prober. This opening can be quickly and easily re-welded without further preparation and without a backing plate.

The Weld-Prober is basically a spherical saw driven by an electric motor through reduction gearing. Mounting is such that opposing positioning produces the specimen shown . . . up to 1¼" deep.

The Weld-Prober will operate equally well on flat, vertical, horizontal or overhead joints . . . or on irregular and cylindrical surfaces such as pipes and on concave surfaces as the insides of vessels.

USED BY

U. S. Navy yards, Shipbuilders, Tank manufacturers, Boiler makers, Public Utilities, Refineries, Auto and Farm Machinery producers, Pipe Line contractors, Structural Steel fabricators.

ADVANTAGES OF WELD-PROBER TEST

1. Positive check on welder's workmanship.
2. Mechanical and physical properties of welded joint ascertained from completed work.
3. Removal of solid specimen containing full portion of welded joint.
4. Specimen large enough to be machined into test pieces for laboratory tests.
5. OPENING EASILY RE-WELDED.
6. Strength of joint not decreased.
7. Appearance of seam not impaired.
8. Test can be made in any position and on irregular surfaces.
9. Weld-Prober is portable and can be handled by one man.
10. Weld-Prober is easily operated and does not require expert handling.
11. Test is practical and economical.
12. Does not interfere with or hold up production.

Write for our descriptive booklet, "THE WELD-PROBER"

Sold Everywhere thru Leading Distributors and Dealers

The FIBRE-METAL Products Company | CHESTER PENNA.

WELDING HELMETS · SPEEDY ATTACHMENTS · SUPERGUARD HATS & CAPS · INSULATED FIBRITA MOLDED · FACE SHIELDS · WELD CLEANING HAMMERS · PROSHIELD SYSTEMS

all signs point the same way...

Throughout the five states now served by United Supply, oil field personnel recognize and follow the signs that unfailingly point to the kind of service the oil industry demands. Such service is always found at your nearest United Supply store.

UNITED SUPPLY

AND *Manufacturing* COMPANY

TULSA, OKLAHOMA

Stores in:
KANSAS, OKLAHOMA, TEXAS, LOUISIANA, AND NEW MEXICO

from storeman-advanced to sales representative at Kermit, Tex.; and Rex O. Dulaney, formerly storeman-advanced at McPherson, Kans., is now a sales representative at Worland, Wyo.

Bouldin joined J & L Supply in 1935 as a storeman at Kilgore, Tex. He later served as store manager and field salesman at Kilgore, as manager of the Longview, Tex., store, assistant district sales manager in the West Texas district, and assistant district sales manager in the northern Oklahoma district since 1953.

Layne has been with the firm since 1934, when he started as a storeman at Healdton, Okla. Prior to his appointment as district sales manager of the North Texas district in 1952, he had served as local store manager and sales representative at various store points in Oklahoma and Texas.

National Promotes Kretzer, McCloskey, and Miller

James C. McCloskey has been promoted to plant superintendent and Fred P. Kretzer was promoted to chief

J. C. McCLOSKEY

F. P. KRETZER

engineer at the Gainesville, Tex., plant of the National Supply Co. At the same time, John O. Miller was promoted to chief methods engineer.

McCloskey started with the company in 1927 at the Toledo, Ohio, plant. He was promoted to foreman in 1941 and general foreman in 1944. He was transferred to the Gainesville plant when it opened in 1954.

Kretzer was a member of the first class in the company's training program starting in 1948. He held various assignments at the Toledo plant and was transferred to the Gainesville plant as administrative engineer in 1954.

Miller worked at the Toledo plant from 1940 to 1946. He entered the company's training program in 1950, was appointed methods engineer at Toledo in 1951, and transferred to the Gainesville plant in 1954.

Pacific Pumps Opens New Store, Appoints Harris

Pacific Pumps, Inc., Huntington Park, Calif., has opened a new plunger-pump store in Kimball, Neb. Charles

ACCURATE
CONTROLLED
Timed
LUBRICATION
The New 82-V vacuum pumping unit "with dry sight feed," an exclusive Manzel development will end your liquid sight feed problems. Install them on any existing Manzel lubricator. Now — more accurate than ever . . . it will pay you to get complete detailed information on this dependable, field-proven Manzel unit.
WRITE FOR COMPLETE CATALOG
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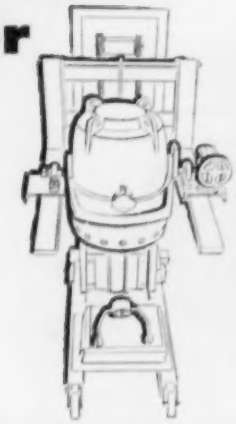
A Division of Houdaille Industries, Inc.

THE KEL-RAY® Projector

Radiographic

TOOL



Portable • Safe • Economical • Easy to Use

Here is a versatile tool that "looks through" metal and allows you to see on film the internal structure of castings, welds or fabricated assemblies before you OK them for service. Such pre-service testing lowers future replacement costs, safeguards against service failures, helps to establish and maintain quality standards that invite more business, and offers an economical method of examining metal structures inaccessible to many types of equipment.

KEL-RAY Projectors employ radioactive cobalt, iridium, or cesium as a source of gamma rays. Built in three portable sizes, the smallest of which can be moved by hand, each is suited to specific applications depending on the source used and the radiation pattern required. Designed to withstand rough handling, Kel-Ray Projectors are safe, economical to own and operate, simple to use for anyone properly trained.

KEL-RAY Projectors can keep an economical eye on the castings, welds, or assemblies on which *your* future business depends.

• *For information, please write.*

METAL & THERMIT CORPORATION

GENERAL OFFICES: RAHWAY, NEW JERSEY

WELDING SUPPLIES • RADIOGRAPHIC EQUIPMENT • PLATING MATERIALS • ORGANIC COATINGS
CERAMIC MATERIALS • TIN & TIN CHEMICALS • METALS & ALLOYS • HEAVY MELTING SCRAP

SET-UP FOR SPEED and SAFETY

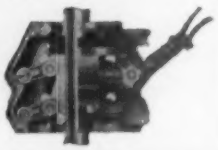
KINZBACH AUTOMATIC TUBING SPIDER

POSITIVE GRIP
AUTOMATIC ALIGNMENT
ONE-MAN OPERATION
FULL SIZE RANGE

The Kinzbach Automatic Tubing Spider handles tubing through 3". It is rated at a 150,000 pound operating load.

For complete information write for Bulletin 23151.

Slip Set. Slip segments are parallel with the centerline of the pipe. Handle is locked in "closed" position.



KINZBACH TOOL CO INC

KINZBACH TOOL CO., INC.
P. O. BOX 277 HOUSTON 1, TEXAS
Export Office: 74 Trinity Place, New York, N. Y.

Oil Loans

THE 1ST NATIONAL BANK OF SHREVEPORT

LOUISIANA'S OLDEST BANK

ROBERT F. CASHEN — Manager Petroleum Department

L. Rosenlieb, formerly Pacific field salesman at Great Bend, Kans., has been appointed manager of the new store.

J. W. Harris has been appointed development and research engineer for A.P.I. equipment at the firm's headquarters in Huntington Park. Harris, who has been with Pacific 12 years, has just completed a 2-year research program for Dresser Industries, Inc., the parent corporation of Pacific Pumps.

Reekstin Named Chief Engineer by Axelson

R. W. Reekstin recently was appointed chief engineer, petroleum equipment products, for Axelson Manufacturing Co., a division of U. S. Industries, Inc. The announcement was made by Roy C. Heacock, director of engineering for Axelson.

Formerly, Reekstin was in charge of the petroleum technical service group as engineering manager. In his new capacity, he will be in charge of engineering for pumps and rods as well as Axelson's complete line of hydraulic surface pumping units.

Parkersburg Division Makes Field Sales Changes

At a management meeting of sales, engineering, and manufacturing departments, presided over by Bernard P. McDonough, president of Parkersburg-Aetna Corp., A. G. Evans-Lombe, vice president and general sales manager of the Parkersburg Division, announced the following important changes in the field sales organization.

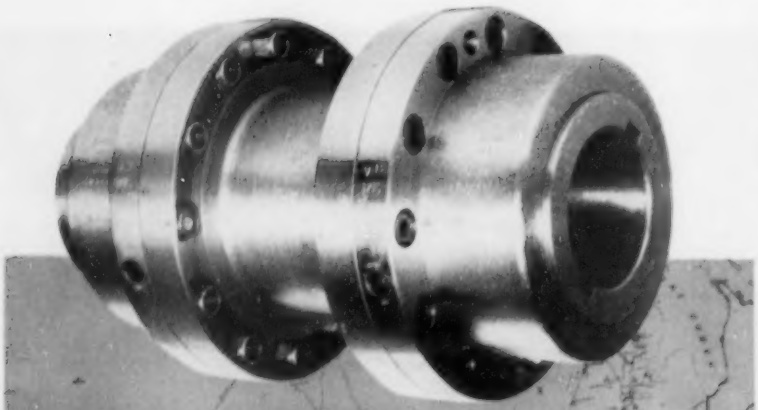
J. W. Robbins, formerly manager of the Gulf Coast-Mexico division, has been promoted and transferred from Houston to Fort Worth as manager of the oil-field sales department. He will have complete supervision over all divisions in the United States, Mexico, and Canada.

W. J. Slaughter, formerly manager of the Rocky Mountain division, has been promoted and transferred from Denver to Fort Worth as manager of the pumping unit division. He will have complete supervision over engineering, manufacturing and sale of pumping units.

C. D. Haehl, Jr., formerly area salesman, has been promoted and appointed manager of the pressure vessel division. He will have complete supervision over the engineering, manufacturing and sale of pressure vessels and will continue to be located in Houston.

W. H. Land has been transferred from Odessa to Houston as manager of the Gulf Coast-Mexico division. He

With that
new production process . . .
A NEW FIRE HAZARD?
When you develop new processing techniques, don't overlook the new fire hazards they may create . . . particularly where flammable liquids are involved. Consult National Foam to obtain recommendations for proper fire protection. There is no obligation, of course.
NATIONAL FOAM System, Inc.
West Chester, Pa.
NATIONAL FOAM SYSTEM
The only company exclusively engaged in the design, development and manufacture of foam fire protection equipment and chemicals



OIL FLOWS

Coast to Coast

WITH THE AID OF

Waldron

COUPLINGS

Throughout the vast network of the principal pipe line systems . . . WALDRON Gear Couplings are specified and are being used by refineries and pumping stations alike . . . they know that WALDRON coupling operating advantages lie in their accurate machining . . . their superior design . . . their proven service throughout the years.

Our Catalog 57-G gives complete data on sizes, types, dimensions and ratings. Write for it.

JOHN WALDRON CORP. • NEW BRUNSWICK, N. J.

Sales representative in Principal Cities

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STANDARD TYPES

Waldron COUPLINGS

SPECIAL TYPES

will be succeeded as manager of the West Texas-New Mexico division by B. D. McClellan who has been serving as assistant division manager.

C. M. Ferguson, formerly assistant manager of the Mid-Continent division, has been promoted and transferred from Tulsa to Denver as manager of the Rocky Mountain division.

M. L. McLafferty, formerly branch manager at Odessa, Tex., has been promoted to district manager, and G. W. Hendricks of Dallas has been promoted from salesman to district manager. Both McLafferty and Hendricks will continue in their present locations. J. D. Connor was promoted from salesman to branch manager at Odessa.

J. L. Norris has been promoted from branch manager to district manager of Oklahoma and will continue to make his headquarters in Oklahoma City. Freed Little has been appointed district manager of Kansas and will continue to be located at Great Bend.

Schlumberger Appoints Monson, Promotes Dennis

The naming of Charles E. Monson as manager of Schlumberger Well Surveying Corp.'s district office in Newhall, Calif., and the promotion of Clyde B. Dennis to field sales engineer at New Orleans for the South Louisiana division have been announced.

Monson joined Schlumberger in 1951. He has served in several California locations including Bakersfield, Sacramento, Ventura, and Santa Maria.

Welex Names Three Sales Appointees, District Mgr.

Larry F. Drake has been appointed assistant sales manager of Welex Jet Services, Inc., Fort Worth, Tex.; Ralph

L. F. DRAKE

VANDERSLICE

Lynn Vanderslice has been named manager of the Shawnee, Okla., district; and Clifton C. Seamon, Jr., and Wade S. Woodruff have been named sales engineers at Farmington and Houston. These appointments were announced by Jack B. Vaughan, vice president, sales.

Drake had served as district and division sales engineer for the Welex Oklahoma division before his transfer to Fort Worth a year ago as Fort Worth sales representative. A veteran of 15

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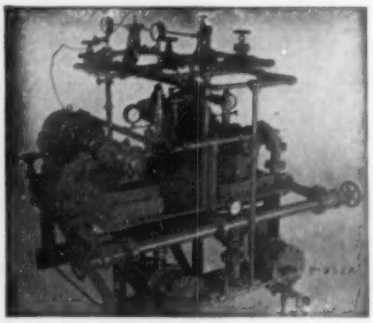

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years in oil-field-service work, Vanderslice has been with Welex for the past 6 years working as loader, rigger, junior shooter, shooter, sales engineer, and assistant district manager before his promotion to district manager.

Seamon joined Welex in 1955. He has served as a shopman and rigger before being promoted to sales engineer. Woodruff was with Petty Geophysical Engineering Co. for 5 years prior to joining Welex in 1953. With Welex he has served as rigger, shooter, and salesman prior to promotion to his present position.

Thomas Named Advertising Manager of Layne & Bowler

J. R. Thomas is the new advertising manager of Layne & Bowler, Inc. Announcement was made by W. H. Reeves, vice president of the firm headquartered at Memphis, Tenn.

Thomas for the past 5 years was an account executive specializing in trade-paper and merchandising activities with Rosengarten & Steinke, Inc., advertising agency of Memphis.

Oilwell Names Store Mgr., Field Representatives

Appointment of Clair E. Lewis as manager of the San Angelo, Tex., store of U. S. Steel Corp.'s Oil Well Supply Division and naming of Billy M. Littlefield and Charles L. Chapman as field representative at San Angelo and Kilgore, Tex., have been announced by William Miskimins, Central Midwest area manager of the division.

Lewis was employed in 1933 by Oilwell and has served as field representative at Odessa and Midland, Tex. Prior to his present appointment he was district representative at San Angelo.

Littlefield joined the division in 1954 at the Anson, Tex., store, where he was located prior to his present appointment. Chapman was employed by Oilwell as a pump repairman at Kilgore in 1953.

Unit Rig Promotes Peycke To Plant Superintendent

The promotion of W. J. Peycke, Jr. to plant superintendent has been announced by J. L. Vint, Jr., president of Unit Rig & Equipment Co.

Peycke joined Unit Rig in 1953 and has held several key positions in the engineering department, the most recent being project engineer of drawworks drives. Prior to joining Unit Rig, he was design engineer for Jensen Brothers Manufacturing Co.

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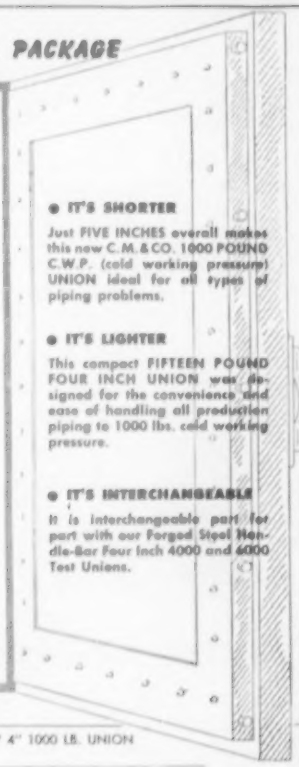

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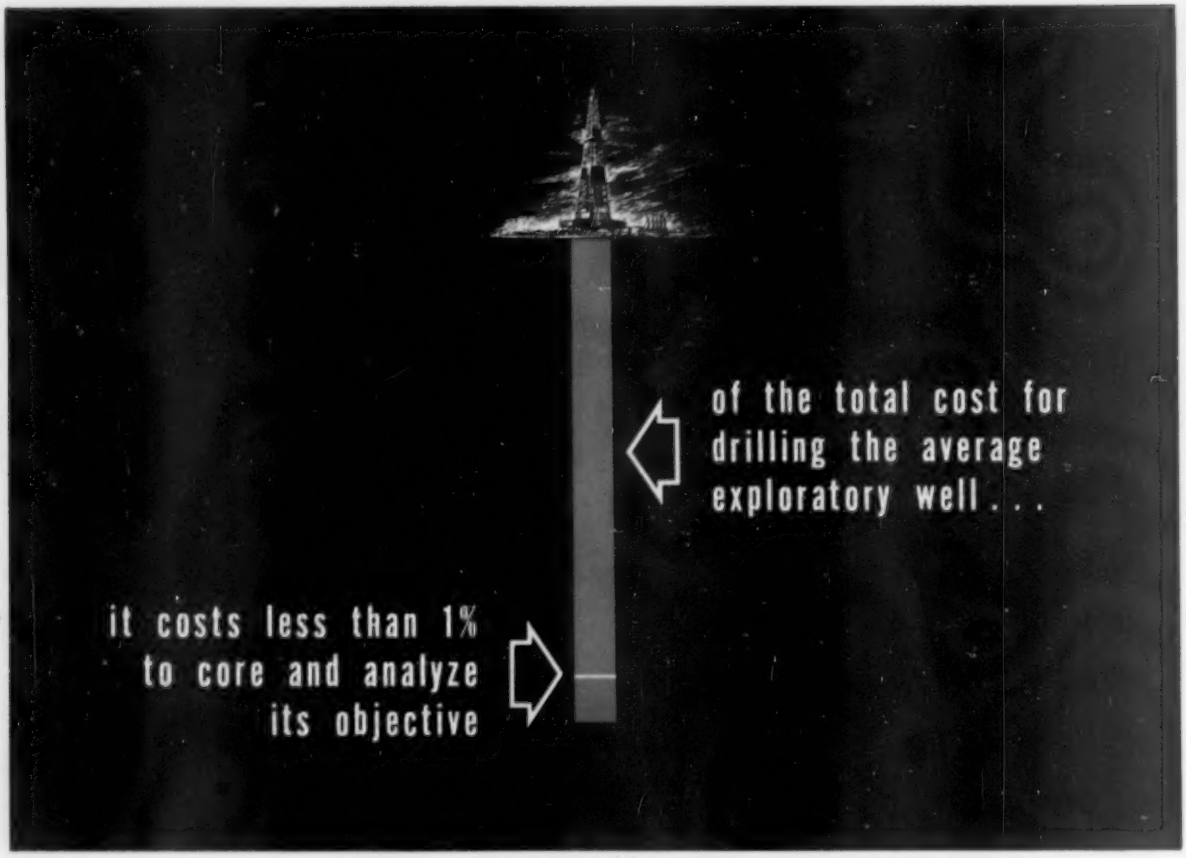

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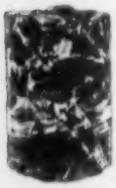

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Alberta Spotlight Shifts to South

by Frank J. Gardner

A SHOWER of new discoveries has burst across the southern plains of Alberta since August 1, and has shifted the exploration spotlight from north to south. These rolling, lake-studded plains were the scene of Alberta's earliest oil activities, but in recent years the turbulent campaigns in the north and west have eclipsed the south.

New vistas . . . There's not enough room on one page to list the bevy of successful and apparently successful wildcats that dot the area of today's map. But the four that are here tabbed all possess more than ordinary geologic interest. They open new vistas in the Calgary-Lethbridge, Cessford, and Medicine Hat arenas.

Only 18 miles north of Calgary, Shell Oil Co. has reported a very encouraging show of light gravity oil in the Cardium sand at its A13-2 Crossfield (Section 2-28n-2w5). A successful completion at the tested level of 6,667-6,818 ft., would push Cardium oil to its southernmost point in the province. On a 1-hour drill-stem test, operators recovered 330 ft. of clean light oil, 170 ft. of mud and gas-cut oil, and 170 ft. of heavily oil and gas-cut mud. They are passing up the sand momentarily to go on down to the Mississippian. A couple of previous wells in the immediate Crossfield area have found the Cardium, but no completion has been made in it. Most production in this region comes from Bow Island-Cretaceous and Mississippian.

Should open oil finder's eyes . . . Down south and along the same trend of operations, Sinclair Canada Oil Co. 1 Dahl (Section 7-13n-27w4) made news. Here, at Claresholm, 65 miles southeast of Calgary and 35 miles southeast of the old Turner Valley bonanza, Sinclair reported a recovery of 5,060 ft. of clean 43°-gravity oil and 390 ft. of oil and gas-cut mud on a 2-hour test of "an unidentified Cretaceous sand" at 5,467-5,528 ft. The unidentified sand lies below the Milk River-Upper Cretaceous sand and could be either Cardium or Bow Island. The discovery lies 18 miles northwest of the nearest oil field at Barons, a Bow Island producer. It is scheduled to test all prospective horizons down to and including the Mississippian, expected at about 8,300 ft., so the final outcome will not be known for a while. It should open the eyes of oil finders to a 100-mile stretch between Calgary and Indian Reservation 148, where only a handful of wildcats have been drilled.

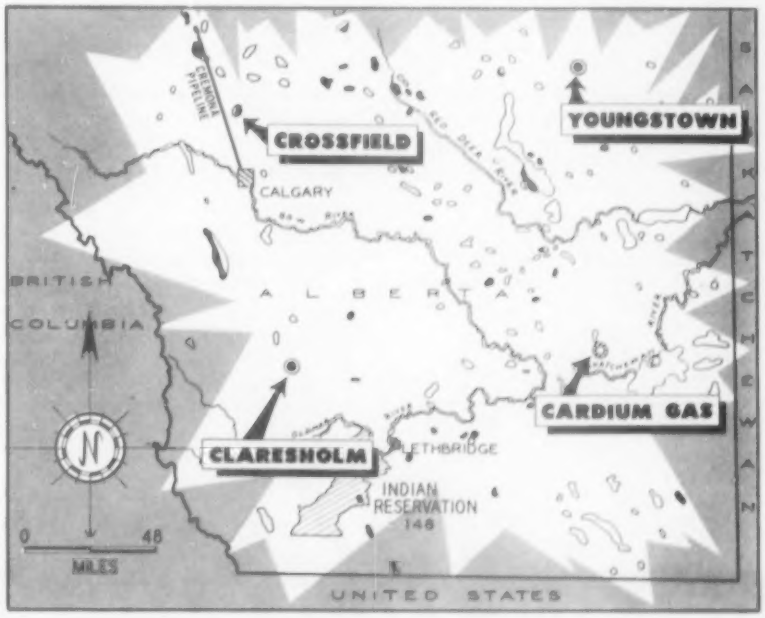
Looking eastward to the Medicine Hat region, the Cardium again makes news. Scurry-Rainbow Oil, Ltd., reported a Cardium gas flow at its 1 Medicine Hat (Section 10-14n-9w4). It was a small show but a significant one, for never before had the sand indicated commercial possibilities in this southeastern gas country.

The discovery lies about 3 miles southeast of Suffield field, a Milk River producer, and 15 miles northwest of Medicine Hat field, producing from the Medicine Hat - Upper Cretaceous sand. It topped Cardium at 1,921 ft. and on 1¼-hour drill-stem test at 1,911-44 ft., flowed gas at a maximum rate of 501,000 cu. ft. per day. Like the other discoveries mentioned, it too is headed for the Mississippian and will go on down to about 3,150 ft. before completion is made.

And set off campaigns . . . The fourth newsmaker lies to the extreme northeast, at Youngstown. Charter Oil Co., Ltd., found Jefferson-Devonian oil at its 6-24 Youngstown (Section 24-31n-10w4). This one lies 20 miles south of the nearest oil field at Hamilton Lake, a Viking-Cretaceous producer.

A Devonian oiler here will set off a spirited campaign for the deeper rocks in the broad region roughly circled by the Red Deer River across the northeastern corner of the map. Here the operators ran two drill-stem tests. The first, at 3,699-3,709 ft., recovered 480 ft. of brown oil and 30 ft. of oil-cut mud in a 1-hour and 10-minute test. The second, at 3,701-16 ft., yielded 590 ft. of dark brown gassy oil and 60 ft. of salt water in 1¼ hours. Charter will carry the well down to the D3 Devonian before completing.

These are just a few of the reasons why Canadian oil eyes are turning southward again. The expensive, inaccessible, deep operations in the north and west begin to pall in the face of shallower, more accessible and cheaper prospects on the southern plains.



Four important discoveries punctuate the accelerated exploration on Alberta's southern plains. All point to impressive new prospects.

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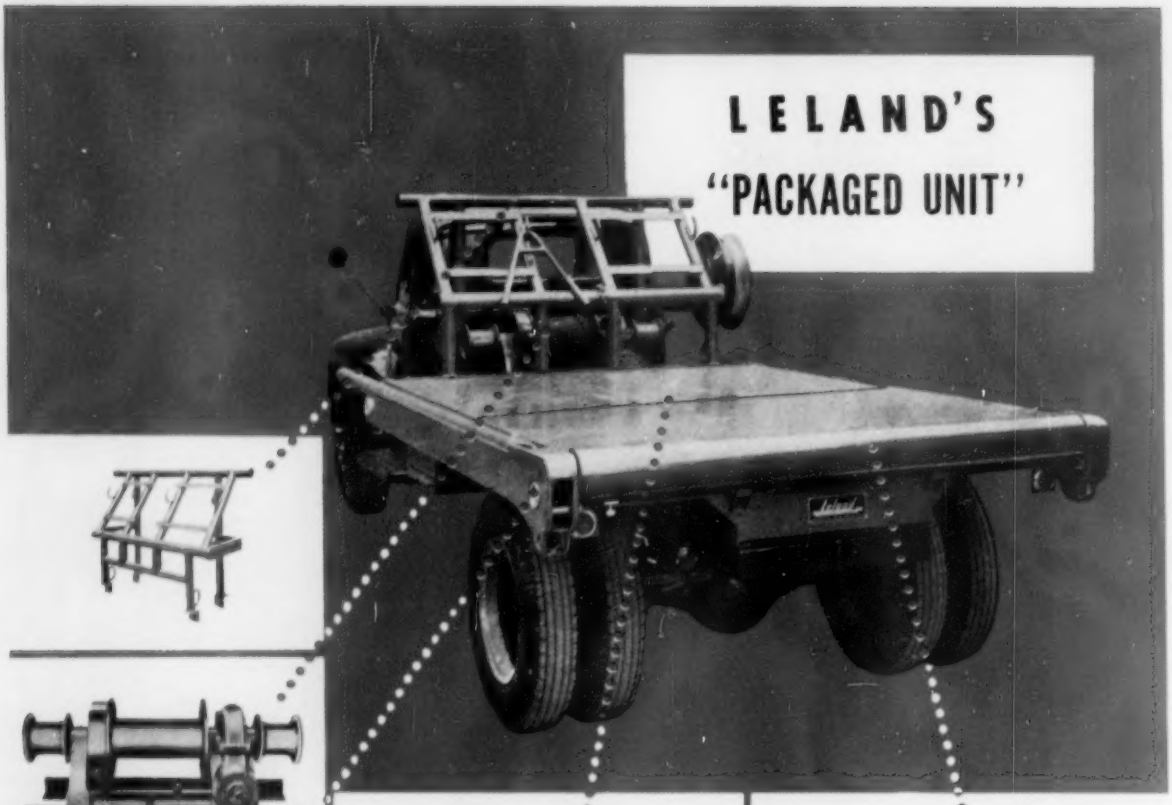

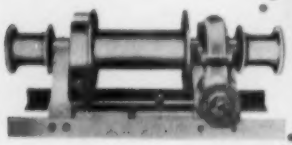

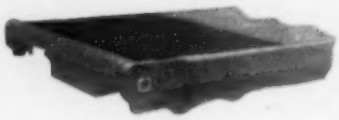

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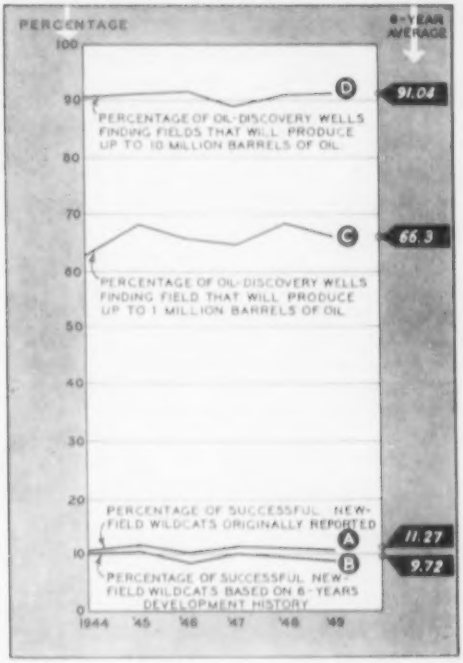

So you discovered oil. You knew the odds against you. But do you know . . .

How Many Fields Really Pay Off?

by F. H. Lahee

IN January 1951, the author published a short paper[1] with the same title as that of the present paper. In it he used statistics on exploratory drilling in 1944, 1945, and 1946. For each of these years there had been at least 4 years of development history following discovery. From this review certain very significant figures were derived, figures which have since been used throughout the country and in many phases of industry and government activity.

The present article presents a series of similar data, but based on 6 years of exploratory drilling, and each of these 6 years of development history.

We have selected the discovery years from 1944-49, inclusive. Thus, discoveries of 1944 had a development history from 1944-49, inclusive; discoveries of 1945 had a development history from 1945-50, inclusive, and so on to 1949, the discoveries of which had a development history from 1949-55, inclusive.

Again, as in the earlier paper, we are reporting only on new-field wildcats, rank wildcats, and only on those drilled in the 17-state area.[2]

In Table 1 are the statistics reported at the close of the year of discovery. In Table 2 are figures for the fields discovered in the same years, but as reported after 6 years of development history. Failures here include not only the dry holes abandoned in the year of discovery (Table 1, col. 5), but also abandonments during the succeeeding 5 years.

It is true, however, that many of these later abandonments did produce some oil or gas, and some of them temporarily in commercial quantities, but their life was short and they did not result in the opening of profitable fields. Essentially, they must be ranked as failures.

Some new-field wildcats, at first thought to be discoveries of new fields, are subsequently found to tie in with fields previously partly developed, and in this case the estimated reserves of the former are added to those of the latter.

With a 6-year period for development, there are likely to be more such additions than with a shorter development history. And again, in a period of 6 years there is more opportunity for augmenting the reserves, attributable to an original discovery wildcat, through outpost drilling and through the discovery of new pools (lateral, deeper, or shallower) on the same structure.

Because of these reasons the estimated reserves of a few fields grow larger for some years before their final decline sets in. It is also for these reasons that the success-to-failure ratios herein presented are somewhat higher than those shown in the earlier article, for which the average development history available for study was less than 6 years.

The scoreboard . . . Bearing these considerations in mind, let us summarize the statistics presented in Tables 1 and 2:

According to Table 1:

(a) There were 1,701 oil discoveries and 608 gas discoveries, or a total of 2,309 new-field wildcat discoveries, as

TABLE 1—NEW-FIELD WILDCATS REPORTED AT CLOSE OF YEAR OF DISCOVERY

1	2	3	4	5	6
Year	Oil discovery wells (plus a few condensate wells)	Gas discovery wells (plus some gas-plus condensate wells)	Total producers (2 + 3)	Dry holes	Total new-field wildcats drilled (4 + 5)
1944	245	84	329	2,695	3,024
1945	237	108	345	2,577	2,922
1946	236	78	314	2,687	3,001
1947	269	106	375	2,843	3,218
1948	356	115	471	3,602	4,073
1949	358	117	475	3,765	4,240
Total	1,701	608	2,309	18,169	20,478

reported at the close of the year of discovery.

(b) Also, as reported at the close of the year of discovery, there was a total of 18,169 dry holes which had been drilled.

(c) The total number of holes drilled in the year of discovery was 2,309 plus 18,169, or 20,478, during the 6 years from 1944-49, inclusive, which means that 11.275 per cent of these 20,478 holes were producers at the close of the year of discovery.

After 6 years of development history for each of the years 1944-49, inclusive (Table 2):

(a) 1,451 oil fields had been developed and the discovery wells were still producing at the end of the sixth year.

(b) 274 gas fields, some yielding condensate, had been developed and the discovery wells were still producing at the end of the sixth year.

(c) 296 oil wells and 22 gas wells, among the original 2,309 discoveries, had been abandoned as essentially uncommercial.

(d) These abandonments (296 oil and 22 gas), added to the 18,169 failures reported in the year of discovery, totaled after 6 years, 18,487 failures out of the original 20,478 holes drilled; that is, 90.4 per cent of those 20,478 holes were failures or near-failures.

(e) 266 wells, at first reported as new-field discoveries, had been found to be extensions of old fields.

(f) The total ultimate recoverable reserves were estimated to be:

1. Fifty million barrels, or more, in 29 fields.
2. Between 25 and 50 million barrels in 19 fields.
3. Between 10 and 25 million barrels in 82 fields.
4. Between 1 and 10 million barrels in 359 fields.
5. Less than 1 million barrels in 962 fields.

(g) Among all the 20,478 new-field wildcats drilled:

1. Only one in 11.9 discovered any oil or gas.
2. Only one in 14.1 discovered oil.
3. Only one in 42 discovered an oil field with as much as 1 million barrels of estimated total ultimate recoverable reserves.
4. Only one in 158 discovered an oil field with 10 million barrels or more of total ultimate reserves.

THE AUTHOR

F. H. Lahee, consultant, Dallas, was graduated by Harvard University with a B.A. degree in 1907. He received his M.A. degree in 1908 and his Ph.D. in 1911. He taught at Harvard from 1906-12 and at M.I.T. from 1912-18. He joined Sun Oil Co. in 1918 and was chief geologist from 1920-40. During the period 1929-32, Dr. Lahee was editor of the Bulletin of the American Association of Petroleum Geologists, and from 1932-33 was president of that association. In 1953 the A.A.P.G. awarded him the Sidney Powers Memorial Medal. For the past several years prior to his retirement, Dr. Lahee was geological and research counselor for Sun Oil Co. in Dallas. He is now a consulting geologist in Dallas. This article originally appeared in the Bulletin of the A.A.P.G., Vol. 40, No. 7, under the title, "Degrees of Success in Wildcat Drilling." The author has adapted and expanded it for presentation in The Oil and Gas Journal.

TABLE 2—NEW FIELDS REPORTED AND ESTIMATED 6 YEARS AFTER DISCOVERY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Total ultimate recoverable reserves (oil or/and condensate) reserves letter symbol								Total producing discoveries	F abandoned		F total abandoned			Wells united with old fields (4 of Table 1 minus 14 of Table 2)
Year	A	B	C	A+B+C	D	E	A to E incl.	Gas	(8 + 9)	Oil	Gas	(11+12)	10+13	All failures	
1944	4	2	14	20	59	137	216	3	219	22		22	241	2,717	88
1945	5	1	13	19	52	151	222	44	266	32	2	34	300	2,611	45
1946	3	2	10	15	53	133	201	39	240	41	1	42	282	2,729	32
1947	4	7	14	25	52	144	221	54	275	43	8	51	326	2,804	49
1948	3	3	20	26	67	199	292	60	352	77	6	83	435	3,685	36
1949	10	4	11	25	76	198	299	74	373	81	5	86	459	3,851	16
Total	29	19	82	130	359	962	1,451	274	1,725	296	22	318	2,043	18,487	266

A means a total estimated ultimate reserve of 50 million barrels or more.
B means a total estimated ultimate reserve of between 25 and 50 million barrels.
C means a total estimated ultimate reserve of between 10 and 25 million barrels.
D means a total estimated ultimate reserve of between 1 and 10 million barrels.
E means a total estimated ultimate reserve of less than 1 million barrels.
F means abandoned.

TABLE 3—PERCENTAGE STUDIES OF NEW-FIELD WILDCATS

	a	b	c	d	e	f	g	h
Year	Reported successful at end of discovery year (Table 1, Col. 4)	Total drilled in discovery year (Table 1, Col. 6)	Per cent of a in b (a/b)	Successful wells as indicated after 6 years of development history (Table 2, Cols. 10 plus 16)	Percentage of d in b (d/b)	Difference between c and e (c — e) (per cent)	Percentage of oil discovery wells finding fields of up to 10 million bbl. of total ultimate recoverable reserves (Table 2, Cols. 6 + 7/Col. 8)	Percentage of oil discovery wells finding fields of up to 1 million bbl. of total ultimate recoverable reserves (Table 2, Col. 7/Col. 8)
1944	329	3,024	10.88	307	10.15	0.73	90.74	63.43
1945	345	2,922	11.81	311	10.64	1.17	91.44	68.02
1946	314	3,001	10.46	272	9.06	1.40	92.54	66.17
1947	375	3,218	11.65	324	10.07	1.58	88.69	65.16
1948	471	4,073	11.56	388	9.53	2.03	91.10	68.15
1949	475	4,240	11.20	389	9.17	2.03	91.64	66.22

5. Only one in 427 discovered an oil field with 25 million barrels or more of total ultimate reserves.

6. Only one in 706 discovered a field with 50 million or more barrels of total ultimate reserves.

In Table 3, and in the chart which graphically presents the data of Table 3, we have listed certain interesting percentages based on the figures in Tables 1 and 2.

Note that curves A and B in the figure refer to relations between producers and total holes drilled (including dry holes), whereas curves C and D refer to producers only.

As stated in the earlier article:[1] "Roughly speaking, and using averages for depth of drilling, number of field-development wells required to drill up a field, number of dry holes drilled to outline the edges of a field, etc., we may assume that a field having a total ultimate recovery of 1 million barrels is, on the average, near the economic limit. In some districts such a small field will pay moderate profits; in others, there will be a net financial loss; all depending on factors of depth to 'pay' or reservoir, difficulties in drilling, permeability and thickness of reservoir rock, accessibility, and so on."

In closing we repeat that the figures here presented are somewhat better than those published in 1951 because of the longer development history available for this study; but, they still emphasize most emphatically that the risk of failure in wildcat drilling is large, certainly not better than one chance of a commercial producer out of every 10 wildcats drilled, even including those producers later found to be extensions of old fields.

References

1. Bull. A.A.P.G., Vol. 35, No. 1 (January 1951), pp. 138-40.

2. The 17 states, in which, during the years 1944 to 1949, inclusive, 95.12 per cent of all the new-field wildcat drilling in the United States was done, are: Alabama, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming.

EXPLORATION HIGHLIGHTS

MID-CONTINENT

OKLAHOMA

Oklahoma Developments Hold Regional Interest

Exploratory and development drilling in Oklahoma currently hold the spotlight in Mid-Continent activity. New discoveries, new pays, and deep wildcatting promise continued heavy drilling throughout the remainder of 1956. Nearly every section of the state is represented in the current drilling spree.

Southwest . . . Most of the drilling punch is directed to the southwestern counties. Deep wildcatting in this region is uncovering some of the most important discoveries in years for the state.

. . . **Susie.** The nominee for the discovery of the year in Oklahoma thus far goes to Sinclair Oil & Gas Co.'s 1

Exploration this week

Mid-Continent	371
Appalachian	377
Eastern Interior	379
Great Lakes	379
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Hugoton Embayment	381
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Rocky Mountains	384
Ark.-La.-Tex.	389
S.E.G. Meeting	389
West Texas-New Mexico	390
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South Texas	392
Southeastern States	393
Successful Wildcats	395

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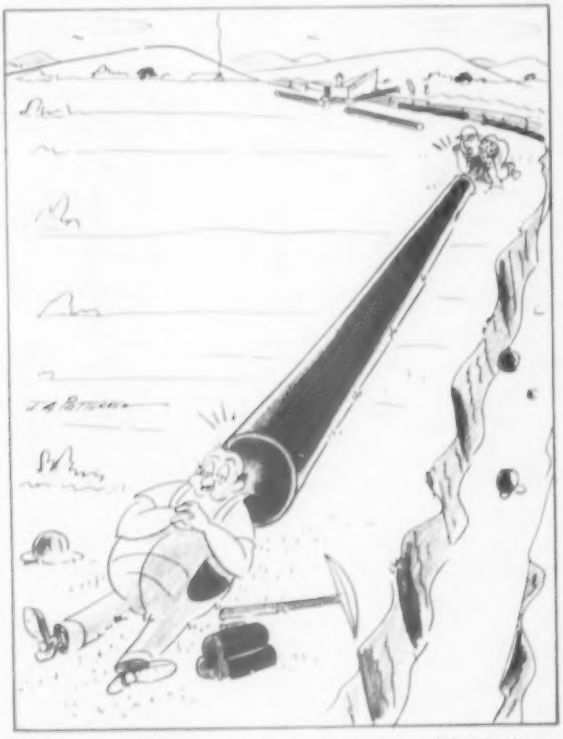
THE OIL AND GAS JOURNAL



"This is your conscience—aren't you ashamed you didn't lend poor old Gus that 10 bucks?"

Susie, a joint effort with Cities Service Oil Co. in NW SE 1-6n-13w, Carnegie district of Caddo County.

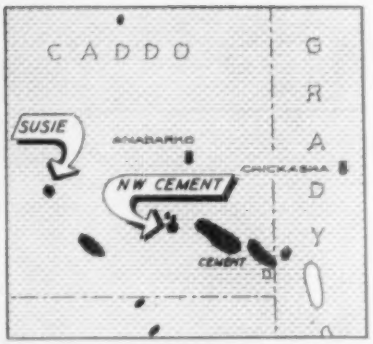
Last week the operators took initial production tests. Perforations in the first Bromide sand at 8,711-96 ft. and in the second Bromide at 8,841-8,907 ft. made a natural flow of 1,186 bbl. per day on ½-in. choke. More tests are under way in the McLish at 9,402-52 and 9,583-9,608 ft.

Total effective pay zone in the Ordovician sands at the 1 Susie discovery is more than 200 ft. Location of this important discovery for Oklahoma is northwest of Apache field.

... Northwest Cement. Another possible major oil discovery is in the making at Amerada Petroleum Corp. 1 Gish, NW SW NW 19-6n-10w, Caddo County. This well flowed 65 bbl. of oil hourly and final flow was 425 bbl. in 16 hours on 18/64-in. choke. The first well in the new area flowed 21,000 M.c.f. of gas per day from the Wade and Marchand sands. It was the 2 Young in SE NE SW 19-6n-10w.

Three successful wells in this new area have shown five producing sands to be effective. There were 85 ft. of pay sand in the Medrano, 50 ft. in the Rowe sand, and 175 ft. in the Marchand sand.

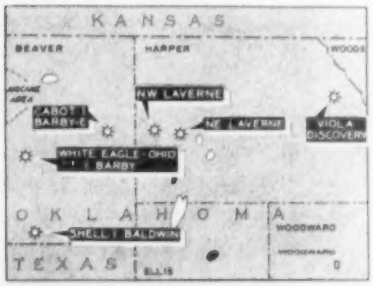
... Beckham. Considerable gas development is under way along the Greer-Beckham county line in the Erick gas district. Phillips Petroleum Co.'s 1 Ellis in NE NE SW 31-8n-25w was completed flowing 3,000 M.c.f. per day from shallow perforations at 1,830-90 ft.



OKLAHOMA EXPLORATORY INTEREST is centered on the Northwest Cement and Susie areas of Caddo County.

Northwest . . . Pennsylvanian and Mississippian discoveries in the Harper and Beaver County areas in northwestern Oklahoma continue to keep this region in the drilling picture.

One of the most important new areas in this section is Baldwin in NE NE 30-1n-26eCM, southeastern Beaver County. Shell Oil Co. and White Eagle Oil Co.'s 1 Baldwin flowed 235 bbl. of oil in 13 hours, or 450 bbl. per day from perforations in the Missouri-Penn at 5,984-6,016 ft.



NORTHWESTERN OKLAHOMA is one of the busiest areas in the Mid-Continent province. Focal points of exploration and development are eastern Beaver County and the Harper County Laverne district. A rank Viola discovery in eastern Harper promises new interest in the Woods-Harper County shelf areas of the Anadarko basin.

The booming gas area in western Harper County gets closer to the Beaver County area each week. The latest addition is Cabot Carbon Corp.'s 1 Barby-E in SE NW SE 31-4n-28eCM, Beaver County. The shallow Hoover sand discovery flowed 1,200 M.c.f. per day from perforations at 4,318-34 ft. It later made 32,600 M.c.f. daily after treatment.

In Harper County's Laverne district

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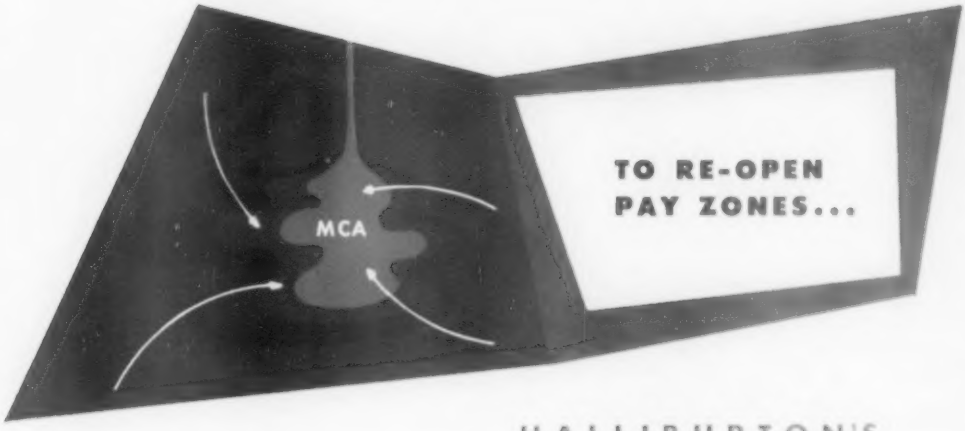

HALLIBURTON'S MCA MUD CLEANOUT AGENT

The disappointing performance of some wells, especially those drilled with water-base or oil-in-water emulsion muds, is often due to blocked flow channels . . . plugged by the intrusion of mud particles and fluid loss into the producing formation. To re-open pay zones, Halliburton's MCA provides the chemical and physical action necessary to break down filter cake and disperse it, forming an easily removed fluid mixture. It does the clean-out job that helps turn potential into profit.

RELEASES IMPRISONED OIL

MCA does a better clean-out job down-hole because it attacks and removes accumulations of mud solids and emulsions that follow drilling operations. The hydrochloric acid in MCA reduces the water adsorptive power of bentonitic materials, causing them to shrink in volume. Morflo, the highly active surfactant in MCA, softens the acid contacted mud and disperses its particles, making it easier to flush them from the well. Morflo also gives MCA excellent wetting properties which facilitate chemical reaction, break down water blocks and make possible easier recovery of the treating fluid. With fractures and flow channels freed of obstructions, the permeability of the pay zone is substantially improved.

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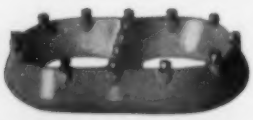

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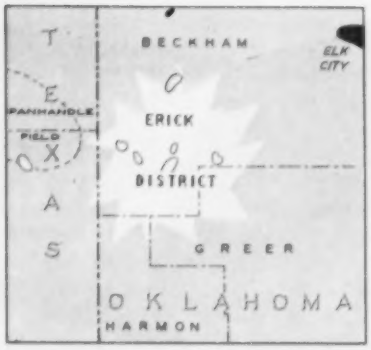


CONSIDERABLE GAS EXPANSION is reported in and around the Erick gas region along the Beckham-Greer County line in southwestern Oklahoma.

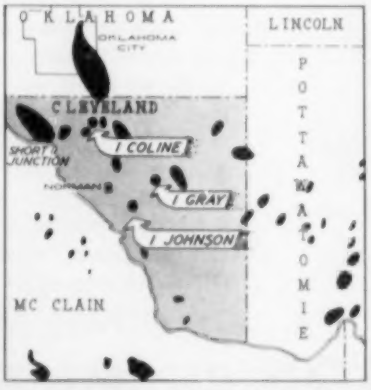
Magnolia Petroleum 1 Barby in Northwest Laverne field flowed 27,500 M.c.f. of gas per day and 9 bbl. distillate per million from Mississippian-Chester perforations at 6,895-6,918 ft., a new pay for the area.

Shell Oil Co. has added another new pay to Northeast Laverne field at the 1 Sturgeon in NE NE SW 2-26n-25w. This Hoover-Penn well flowed 18,000 M.c.f. of gas per day. On the east side of Harper County Woods Petroleum Co. opened Viola lime production at 1 Seevers in NW NW 6-27n-20w. The gas-distillate discovery flowed 7,300 M.c.f. per day and 2 bbl. distillate per hour from perforations at 6,960-7,010 ft. This is the westernmost Viola production in the entire province.

. . . Woods County. Amerada has an important extension discovery at its 1 Copenhaver in Oakdale field. This well flowed 180 bbl. Simpson sand oil in 24 hours at 7,447-54 ft. From the Hunton the well flowed 10,000 M.c.f. of gas per day at 7,126-40 ft. Other pay sands are Layton, Cherokee.

South-Central . . . New discoveries in Cleveland County enhance this region's potentialities. Weimer, Fitzhugh and Pyramid Oil & Gas Co. have a dolomite and Oil Creek sand discovery at 1 Johnson, southeast of Norman. Trice Production and Fain-Porter Drilling Co. 1 Coline, 1 mile from South and Northeast Moore fields, flowed 100 bbl. of oil per hour. An-Son Petroleum Co. 1 Gray is another Oil Creek sand discovery in the Northeast Falls field area. The county's most active areas are: Short Junction, Northeast Falls, Clothier, Northeast Norman, and Northeast Moore pools.

. . . Garvin. In Garvin County Stanolind Oil & Gas Co. has completed a Layton sand discovery in the Eola dis-



CENTRAL OKLAHOMA DRILLING continues high, particularly in the Norman, Moore, and Short Junction areas.

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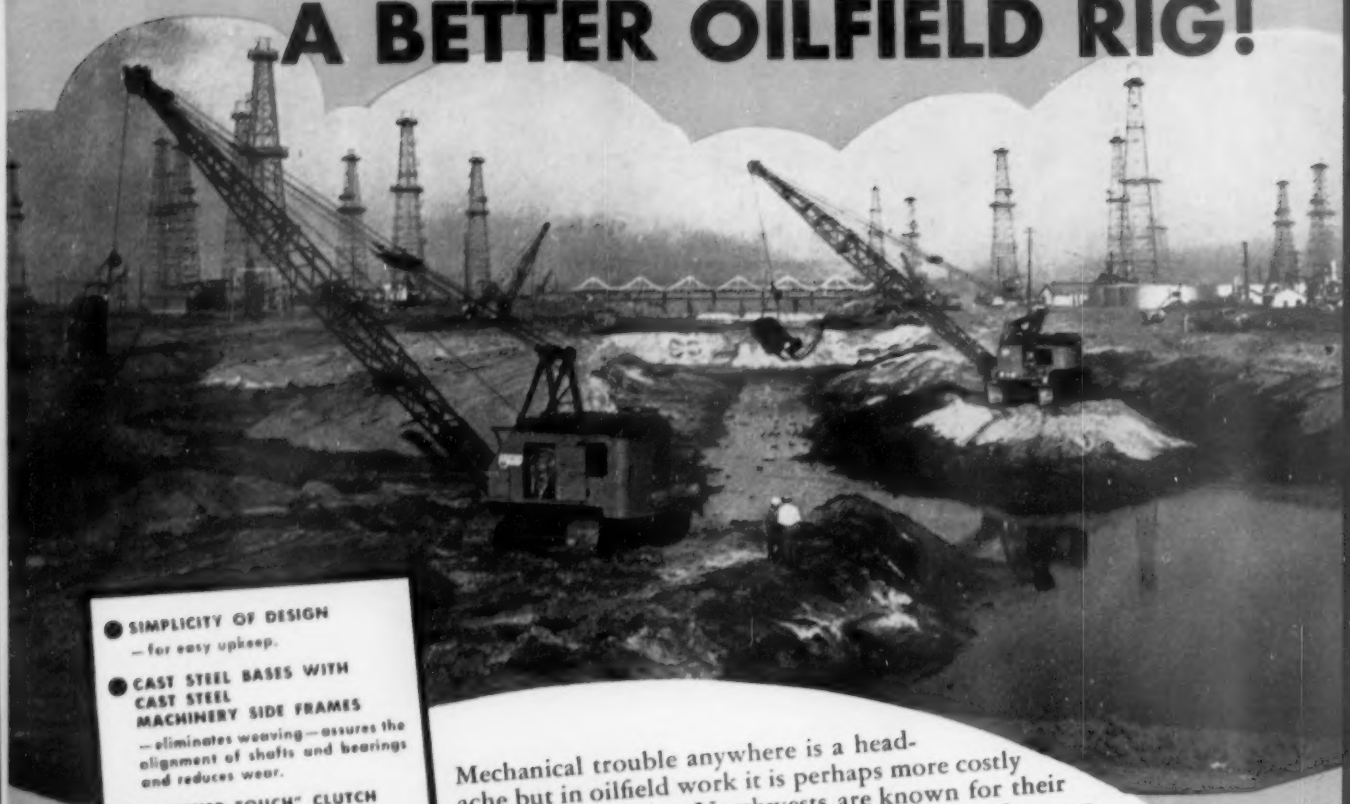

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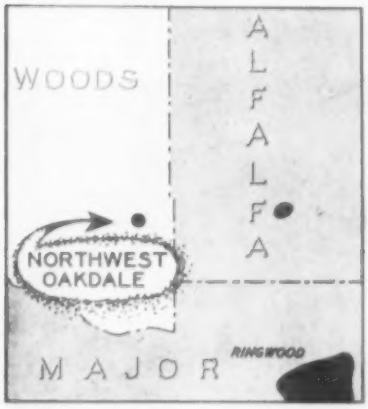
SOUTH-CENTRAL OKLAHOMA drilling is particularly heavy in the Robberson-Eola district.

trict. The 1 Bradfield flowed 242 bbl. of oil per day.

Pure Oil Co. has a Viola lime discovery at 1 Racestraw, flowing 10 bbl. per hour on small choke. The An-Son 1 Ledgerwood-A in 17-4n-2w, is a Viola discovery in a recently opened Bromide sand pool. Good drilling results are reported in Garvin County's Robberson-Eola area.



SUCCESSFUL EXTENSION of Oakdale field in Woods County is reported at Amerada Petroleum Corp. 1 Copenhaver.

APPALACHIAN

PENNSYLVANIA

Young Township, Indiana County, Southwest Pennsylvania, Manufacturers Light & Heat Co. 4336 Stewart and R. & P. Coal Co. shut down at 7,498 ft. The gas in the top of the Oriskany sand now tests 179,000 cu. ft., with a rock pressure of 2,100 psi. in 29 hours. The well will be fractured.

• Mount pleasant Township, Westmoreland County, Peoples Natural Gas Co. is running tubing in 4092 J. G. Mailey at 7,476 ft. to fracture.

WEST VIRGINIA

In Licking district, Tucker County, West Virginia, Hope Natural Gas Co. 9993 Earl Fike, wildcat, elevation 1,921 ft., gaged 8,200,000 cu. ft. gas, after fracture. The chert was at 4,684 ft., gas 4,800 ft., Oriskany sand 4,916 ft., gas 5,018-5,021 ft. Total depth 5,192 ft.

OHIO

A wildcat 3 miles southeast of Wooster oil field looks like a large producer and pool opener. Drilled by the Smith Petroleum Co. on C. G. Baker, Section 15, Franklin Township, Wayne County, the Clinton was topped at 3,519 ft. and flowed 20 bbl. natural and is reported as flowing 8 bbl. per hour through a small choke after fracture.

One of the largest initial producers after fracture was completed on 6 Elsie Carson, Section 15, Hopewell Township, Muskingum County, in the east part of Flint Ridge field. The operator, Coury & Bumgard, logged the Clinton at 3,274 ft. to 3,314 ft. with 1,200 bbl. oil and 800,000 cu. ft. gas in the first 24-hour test.

EASTERN KENTUCKY

On Marrowbone Creek in the Pike County sector of Big Sandy gas field, Kentucky West Virginia Gas Co. has successfully completed a deepening operation at its 6081 Harrison Ratliff. From an old total depth of 2,510 ft. in Mississippian Maxon sand operator drilled to a new depth of 3,069 ft. Big Injun (Mississippian) sand topped at 2,986 ft. showed gas naturally at the rate of 343,000 cu. ft. daily from 3,024 to 3,032 ft. After shot well gaged initially at the rate of 539,000 cu. ft. daily.

Eastern Kentucky's deepest test currently drilling is that of Kentucky West Virginia 6333 Philip Dingus now below 5,118 ft. in Trenton lime. Well will test Lower Ordovician and Upper Cambrian sediments and is located in Floyd County.

EASTERN INTERIOR

ILLINOIS

One New Oil Pool In Illinois in August

One oil field was discovered in Illinois in August. Chesterville pool in Douglas County, according to the State Geological Survey Division of the Department of Registration and Education.

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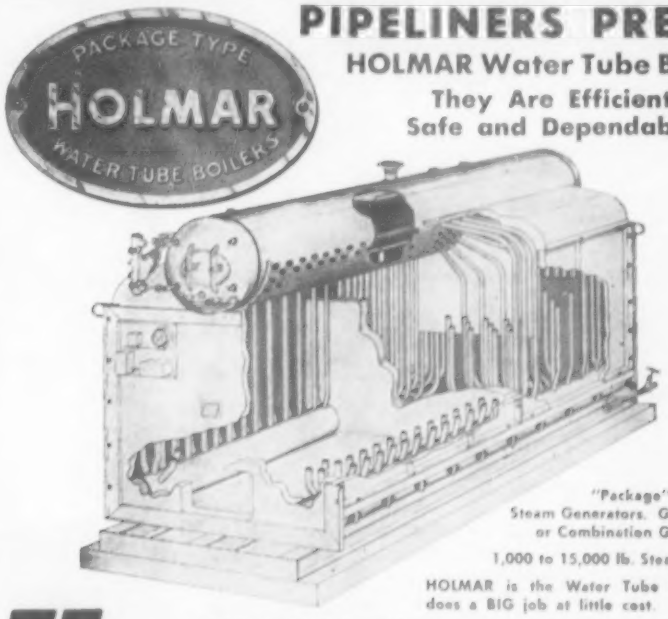

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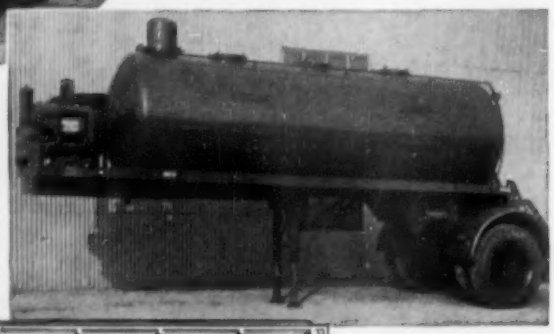

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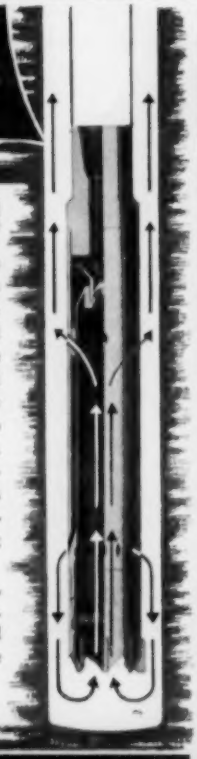

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the first producing oil well was completed in Douglas County, the discovery well of the Murdock pool. A few months later drilling in the Cooks Mills area in Coles County crossed the county line into Douglas. Since the beginning of this year, three more Douglas County pools have been discovered: Bourbon, Bourbon North, and now Chesterville. Production is from the Rosiclare. Forty-three wells completed in Douglas County in August, including 26 producing wells. This was the largest number of wells drilled in any county; Wayne placed second, with a total of 26 wells drilled. Sixteen of the producing wells were in the Bourbon pool. Initial productions were above average, ranging from 40 to 400 bbl. One gas and eight oil wells were completed in the Douglas County part of Cooks Mills Consolidated pool. Initial productions ranged from 150 to 400 bbl. At the present time, there are about 90 oil wells and 2 gas wells in Douglas County, all drilled in less than a year.

Also in August, six extensions to pools were discovered, two to the Fishhook pool in Pike County, and one each to Ingraham and Hord South in Clay County, Harco in Saline County, and Maple Grove Consolidated and Barnhill in Wayne County.

A total of 315 wells were completed in August, including 143 oil wells and 9 gas wells.

Production for the month was estimated to be 7,099,000 bbl., a daily average of 229,000 bbl.

Skiles Completes Three Producers

Skiles Oil Corp. of Mount Carmel, Ill., has set pipe on their 1 C. Lipper, in Vanderburgh County, producing 35 bbl. daily from the Mansfield.

The 1 Pielmeier, southeast of Inman in Gallatin County, has just been completed for 45 bbl. per day in the Waltersburg sand.

The 1 Hudson "B" in Crawford County, was put on the pump late in August and was making 173 bbl. per day from the Benoist on September 4. Skiles set pipe on an offset to the 1 Hudson "B" on September 5.

GREAT LAKES

MICHIGAN

Grout Development Is Disappointing

The new Grout Richfield oil development, Grout Township, Gladwin County, has been disappointing since tests of the discovery well were started. This week a second disappointment appeared as the west 40-acre offset to the discovery was tested in Richfield with prospects less encouraging than were preliminary tests at the discovery.

This new Grout well, Sun Oil Co. Unit B-1 Linaberry, NE NE SW 10-18n-2w, failed to show oil-bearing porosity at points from which the discovery well is being produced. However, a thinner, shallower pay in the Richfield was cored and is being tested.

Top of Richfield at this west offset to the Grout discovery well was logged at 5,020 ft. First drill-stem test was run at 5,019-76 ft. Well showed for a maximum of 17,000 cu. ft. of gas, 300 ft. of oil, 180 ft. of oil-cut drilling mud and 50 ft. of water. Second drill-stem test, with straddle packer, testing zone between 5,010-30 ft. to determine if an oil-water separation can be effected, was being run. Another core may be cut.

PACIFIC COAST

CALIFORNIA

Union Nears Good Find At Mountain View

Union Oil Co. recovered 66 bbl. of clean 25°-gravity crude on a formation

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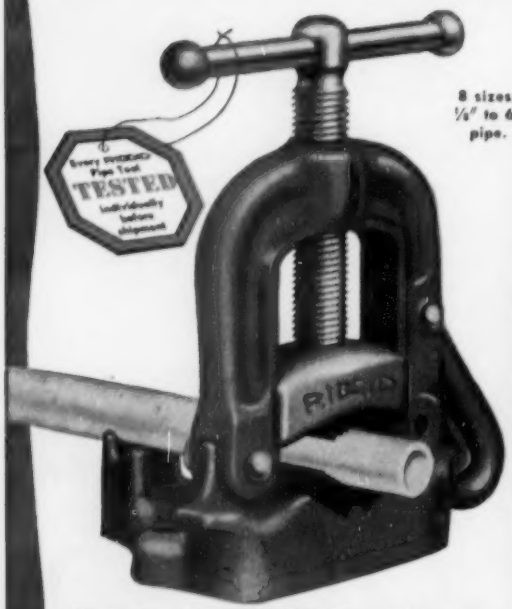

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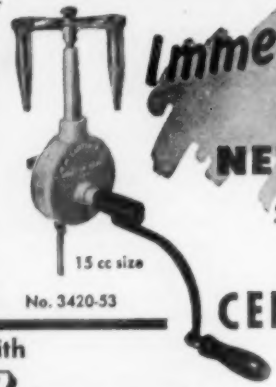

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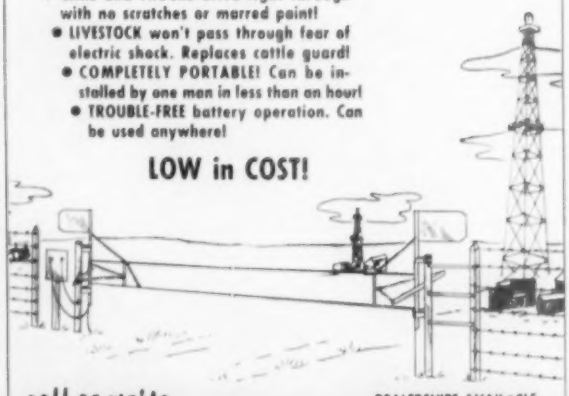

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test of its wildcat, 55 Stenderup, 1 mile west of the town of Arvin near the Mountain View field, Kern County. The interval tested, 9,559-9,729 ft., is the upper Miocene between the Santa Margarita and Vedder. Union was drilling ahead below 10,000 ft. in a deeper test of the Vedder.

Texaco Scores at Placentia

The Texas Co. gave the Placentia area, Orange County, a new pool discovery with completion on the pump of 1 Dowling for more than 200 bbl. daily. This wildcat, located in SW NE 31-3s-9w, is ½ mile from the nearest producer in the Richfield oil field. The perforated interval is 7,950-8,073 ft. Total depth is 8,115 ft.

Shell Hits at Strand

Shell Oil Co. continued its record of successful wildcatting in Strand field of Kern County with another new pool discovery on the southeast flank of the regular producing area. This time Shell moved ½ mile away to complete 34-17 KCL as a pool find at 9,242-69 ft. The test, located in SW NW 17-30s-26e, flowed 600 bbl. daily of 29°-gravity crude through a 48/64-in. choke.

Texaco Gets Third Big Well at Honor Rancho

The Texas Co. extended production in the southeast area of Honor Rancho field, Los Angeles County, more than ¼ mile west of the discovery with a well that flowed 1,199 bbl. daily of 36.5°-gravity crude through a 20/64-in. choke. The producing interval is 9,135-9,500 ft. This latest completion, 14 Honor Rancho, is the third big well in the hot new area. Texaco has two and Superior Oil Co. one.

HUGOTON EMBAYMENT

SOUTHWEST KANSAS

Mississippian Discovery Inside Hugoton Field

Helmerich & Payne have a new Mississippian oil discovery inside Hugoton field in Haskell County, 4 miles southeast of Pleasant Prairie field. The 25 Jones "O," NE NE SE 25-27-34, 16 miles north of Satanta, Kans., swabbed 20 bbl. of oil per hour from perforations at 5,121-27 ft. in the Mississippian. Other tests are now under way at 5,060-70 ft.

● In Kearny County, Helmerich & Payne's 4 White was potentialed for 180 bbl. of oil per day on pump with production from the Mississippian. This well is in South Side pool, another inside Hugoton producer. Location is 4 miles northeast of Pleasant Prairie field in NE SW NW 13-26-35.

Free Oil Tested at Hodgeman Prospect

Oil and gas shows were reported at a wildcat in remote northern Hodgeman County wildcat country. The possible discovery well is Mayfair Minerals Co. 1 Weiland, SE SE SW 16-21s-22w, 15 miles north of Saw Log Creek field. Pay is either conglomerate or Mississippian. The drill-stem test was made at 4,379-92 ft. and at 4,390-4,402 ft.

TEXAS PANHANDLE

Gas Flows at Ochiltree Stepout

A Cleveland sand stepout test in Ochiltree County flowed 8,000 M.c.f. of gas per day from perforations at 6,732-42 ft. The well is R. H. Fulton 1 Froose-19, southwestern Ochiltree County. Location is in Section 19, Block JT, TWNG Survey, 8 miles south

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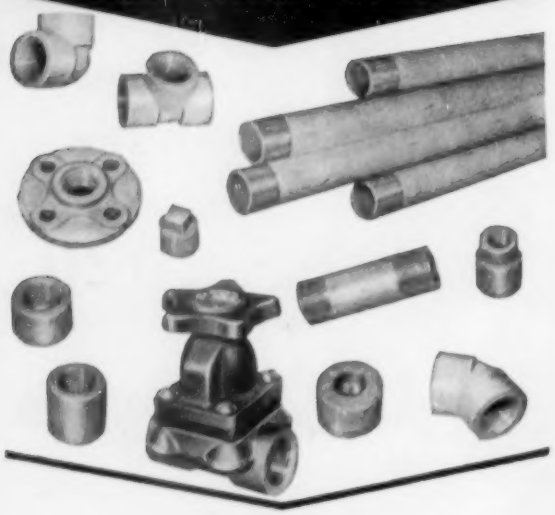

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of Farnsworth and 1 mile south of production.

Shell Oil Co. 1 Schaefer, 1 mile west of R. H. Fulton 1 Barber, a recent discovery well, tested free oil in the Morrow sand at 7,648-60 ft. The last flow gage reported from the well was 319 bbl. of oil during a 12-hour testing period on 1-in. choke. This one is in Section 16, Block 4-T, T&NO Survey.

WESTERN CANADA

ALBERTA

Gas Flow Registered At Obed Wildcat

Imperial Oil, Ltd., has run one successful test in the Rundle formation at its 5-13 Obed wildcat drilled in central west Alberta and has received a gas flow estimated at rate 8,000,000 cu. ft. daily.

This strike, Imperial-Decalta-Partridge 5-13 Obed, on LSD 5, 13-54-23w5, lies 35 miles west of Edson townsite and about 65 miles north-northeast of the resort town of Jasper. Sample top of the Rundle was reported as 10,846 ft. and drill-stem test between the interval 10,860 ft. and 10,900 ft. flowed gas at rate between 7 and 8 million cubic feet daily. There was no fluid recovery. Crew was attempting another test at total drilled depth of 10,921 ft. at last report.

Paddle River Wildcat Gets Mississippian Oil

A previously unreported oil strike in Alberta, drilled by Honolulu Oil Corp. and its associate, Merrill Petroleums, Ltd. on acreage acquired from Canada Cities Service Petroleum Corp. has indicated a substantial potential from the Mississippian formation during recent production test operations. This strike, Honolulu, et al., 16-17 Paddle River, is approximately 65 miles west-northwest of Edmonton and 17 miles north of Lobstick railpoint.

This discovery lies on LSD 16, 17-56-8w5, and was carried to a total depth of 5,391 ft. and production casing was set through the Mississippian pay zone. Perforations of the interval 5,196 to 5,210 ft. were made and then treated with acid.

The well was swabbed into production and then killed to enable crew to install wellhead equipment. When opened up for a 3-hour test through a 16/64-in. choke oil flowed at the rate of 288 bbl. per day. Gas-oil ratio was 400 cu. ft. per barrel and gravity of oil was measured at 18°.

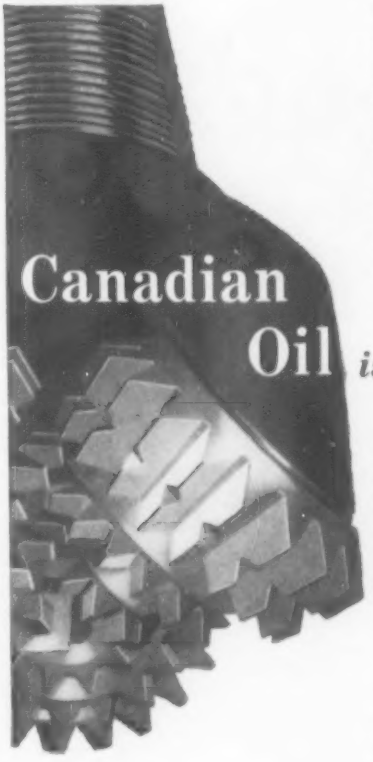
Drill-stem tests at the well in the Mississippian formation were not released, but during the drilling of the well a test in the Nordegg formation, indicated a gas flow and a pipe recovery of light gravity oil. That zone was not tested for production.

Casing Set at Wimborne Discovery

Banff Oil, Ltd., has set production casing at its 4-1 Wimborne D3 zone gas and oil discovery well in the central area of Alberta after indicating 88 ft. of gas distillate pay zone and a 12-ft. oil pay sector in that formation. The gas is especially rich in both condensate and sulfur and the lower part of the pay zone is estimated to contain the 12-ft. oil sector bearing 44°-gravity crude.

This well, Banff 4-1 Wimborne, lies on LSD 4, 1-34-26w4. It is 1½ miles north of Wimborne railpoint and 60 miles north-northeast of Calgary. Previous drill-stem tests at the hole had given gas flows up to 14,000,000 cu. ft. daily and pipe recoveries of condensate were reported.

Latest drill-stem test reported at the hole and last to be run before the casing was set indicated the water line had been contacted. That test, of the interval 7,426-36 ft. had a gas flow rate



Western Canada is the second most active drilling area in the world today, and in 1955 drilling hit an all-time high. The total number of wells drilled was approximately 2,700, an increase of about 25% over 1954. Most experts look to a sizeable increase in drilling activity in Western Canada in 1956 and believe that drilling will probably continue at around 2,500 wells per year until 1960.

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While the Bank is prepared to provide all available information on the oil industry, it does not make recommendations regarding the purchase of individual oil stocks.

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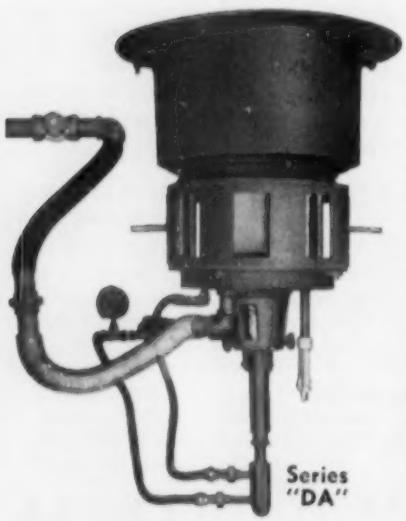

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of between 3 and 6 million cubic feet daily. Condensate and oil sprayed to surface in 27 minutes and when pipe was pulled it was found to contain 680 ft. of oil and 195 ft. of gas-cut salt water.

Jefferson Discovery Reported in Southeast

Charter Oil Co., Ltd., exploratory venture in the Youngstown area of southeastern Alberta has rewarded its backer with a light gravity oil discovery from the Jefferson zone of the Devonian formation (D1 equivalent), and crew is now drilling ahead to its main objective in the D3 sector of the same formation.

Two drill-stem tests completed at the discovery well gave sizable recoveries of dark brown oil, and the second test also yielded a small amount of salt water. The strike, Charter-Cal-Standard 6-24 Youngstown, on LSD 6, 24-31-10w4, is 10½ miles north-northwest of Youngstown town.

Initial test in the zone gave up 480 ft. of dark brown oil while second test indicated 590 ft. of dark brown gassy oil and 60 ft. of salt water. A 17-ft. sector was covered by those two tests but the operator did not state the thickness of the pay sector.

ROCKY MOUNTAIN

UTAH

North Desert Creek Tops Regional News

The Paradox basin, consistently the nation's pace-setter in exploration this year, is back on the wildcat scene in a big way this week. Shell Oil Co. recovered oil at the rate of 1,440 bbl. per day on tests of its 1 North Desert Creek wildcat in C SW SW 12-41s-23e, San Juan County. The interval tested was at 5,578-86 and 5,590-98 ft.

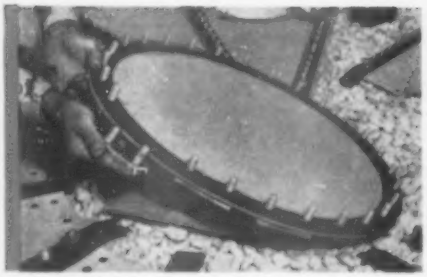
There is only limited outlet facilities in this region at present, necessitating shutting in the well temporarily. Production at this newest of Paradox basin discoveries is from the Paradox member of the Pennsylvanian Hermosa. Location is 3 miles north of Desert Creek field, one of the original birthplaces of basin production. North Desert Creek is also 5 miles south of western tip of Aneth field production.

Field Trip

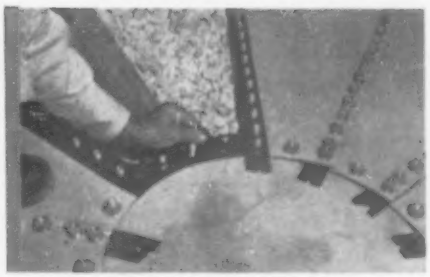
The Utah Geological Society will hold its annual 2-day field conference this year in Box Elder County. The subjects featured will be the geology

Here's Why COLUMBIAN BOLTED STEEL TANKS "Just Fit Up Better"

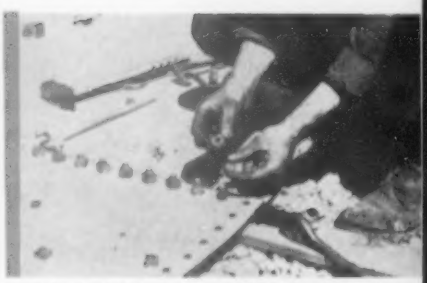
For more than 60 years Columbian steel tanks have been the standard for tank tightness and lasting quality. Why do Columbians "just fit up better"? There are many reasons. First of all, the high-precision machinery Columbian uses in forming and punching the tank plates and decks . . . and the master-craftsmen in steel who operate those modern machines. But beyond that, it's the attention given to assuring the tight seal of every joint and seam when a Columbian tank is fabricated. The pictures here show how easy it is for a crew to fit up a tight tank — when it's a Columbian.



"Rubbering" the bottom: Synthetic gasket material is applied to center plate of Columbian tank bottom. Note short channel lengths for holding bolt heads.



Joining bottom segments: "Rubbered" on one edge and bolted to adjoining segments. Special wedge-shaped gaskets are provided for three-thickness (2 segments and center plate) joints.



Tight-Sealed bolt holes: Steel backed Neoprene washers are provided for all side and bottom seams. As bolts are tightened cup-shaped steel washers press rubber washers tight in and around bolt holes, forming a perfect, leak-proof seal.

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of Promontory Point and the east end of the Raft River Mountains. Further information will be available at the office of the Utah Geological Society, 200 Mines Building, University of Utah, (Phone DAvis 2-4761, extension 505) as supplemental data comes in to the secretary.

Guidebook No. 11 to the Geology of Utah, "Geology of Parts of Northwestern Utah," will outline and discuss the information to be checked in the field. Guidebooks will be available for distribution on Friday morning, September 21, during registration, which will be held on the Tabernacle grounds near the state highway in Brigham City.

Registration will start at 7 a.m. There will be an overnight stop at Snowville where facilities are available for approximately 30 people. Snowville reservations may be made through the society secretary on a first-come, first-served basis, at $2 per person, cash paid in advance.

Participants are urged to provide or arrange their own transportation.

... A thumbnail sketch of geologic highlights to be seen on the trip are as follows:

A fairly complete Paleozoic section occurs in the Promontory range; the major formations will be pointed out from stops along the road to the southern tip. The southern third of the Promontory is underlain by late pre-Cambrian rocks whose units will be pointed out.

A geologic map accompanying the guidebook article will help explain the features of a complex structure. The extensive new operations of the Southern Pacific Railroad in Little Valley will be visited.

The second day will be spent in the Raft River Mountains. The core is of pre-Cambrian sedimentary rocks which are very tentatively assigned by Felix to the midpre-Cambrian.

There is also a series of metamorphosed limestone dolomites and sandstones which contain fragments of Paleozoic fossils. The problem of a highland in this area during parts of the Paleozoic will serve to focus attention. Fault and thrust relations also pose problems of interest.

COLORADO

Oil Recovered at Kiowa Prospect

A Las Animas arch area wildcat reported recovery of 570 ft. of oil on drill-stem tests of the Cherokee-Pennsyl-

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This sea-going barge is entirely protected with Dimetcote. Additional maintenance or recoating is not anticipated until sometime after 1960.

During construction, "Mr. Gus," the famous mobile drilling platform, was coated with Dimetcote. Selection of Dimetcote for this multi-million dollar structure indicates its great value for offshore locations.

Dimetcote is highly recommended for use on: barges, off-shore drilling and production platforms, service boats, christmas trees, caissons, buoys, LTX separation units, floating roof tanks, water tanks, ship decks and stacks—any place where atmospheric or salt water corrosion is a problem.

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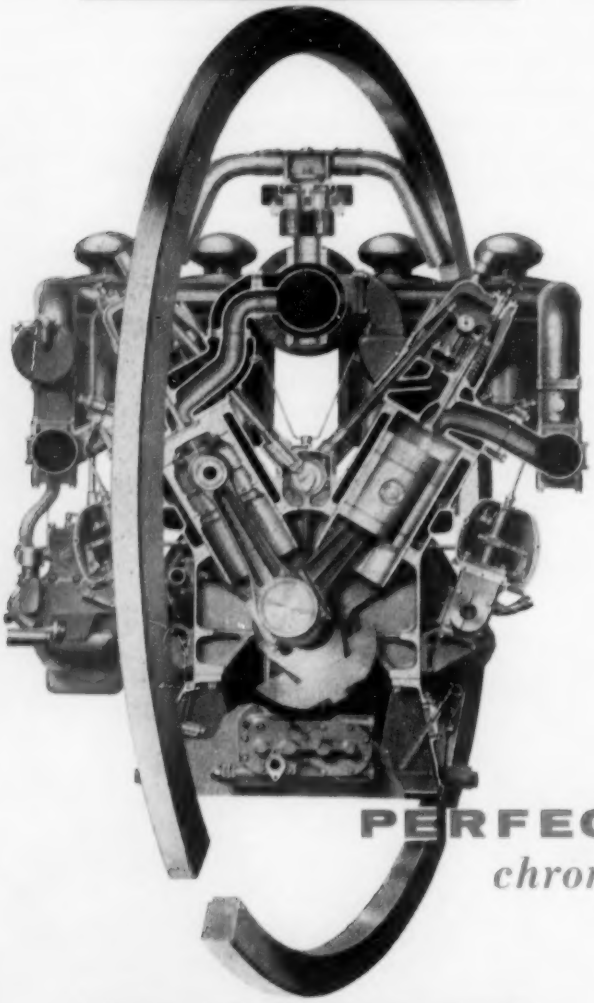

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vanian. This new discovery prospect in one of Colorado's remote wildcat areas is D. D. Harrington 1 Lynn, C SE NW 13-20s-49w, Kiowa County.

Eastern and southeastern Colorado exploration is on the definite upgrade following recent developments along and close to the Las Animas arch. Harrington has another discovery 14 miles southwest of the Kiowa test at 1-A Earl, Bent County. The operator reportedly tested 16,000-22,000 M.c.f. of gas per day from an unidentified Pennsylvanian zone. Bents Fort field lies 14 miles northeast.

North Park Well Flows Oil and Gas

Cabeen Exploration Co. 3-B Blevins in SW NW SE 3-9n-78w, Jackson County, an extension try to Canadian River field, flowed oil at the estimated rate of 10-15 bbl. per hour on drill-stem tests at 2,030-80 ft. in the Lakota. This discovery is the second well in the area to get Lakota oil.

NORTH DAKOTA

Antelope Field Has Four Producers

Amerada Petroleum Corp. and Warren Petroleum Co. got oil at the rate of 45 bbl. per hour on drill-stem test at their 1 Strand in Antelope field, McKenzie County. The Madison prospect is the east offset to the discovery well of the highly promising field, and is the fourth well to be drilled in the area. There is more than 300 ft. pay zone in the field.

ARK-LA-TEX

EAST TEXAS

Slocum Area Drilling Maintains Good Pace

Three completions and three new tests were reported from the Slocum fields in southeastern Anderson County last week.

On the northeast side of North Slocum field, Monsanto Chemical Co. 1 Nannie, in the A. Killough Survey, flowed 200 bbl. of oil a day through 12/64-in. choke. Sub-Clarksville sand was perforated at 5,668-80 ft.

In the West Slocum-Woodbine field, M. L. Mayfield 1 Springman estate, W. R. Silson Survey, completed for 141 bbl. a day through 10/64-in. choke. Gas-oil ratio was 801:1, and pay was perforated at 5,752-55 ft.

In South Slocum field, Thomas D. Humphrey & Sons 1-A Wallace, in W. T. Sadler Survey, rated 136 bbl. of oil a day from the Woodbine at 5,957-60 ft. The flow was through 10/64-in. choke, with gas-oil ratio of 1,684:1.

New work for the area included two tests by Thomas D. Humphrey in South Slocum field. These will be 2 A. L. Gibson and 2-A G. B. Wallace. Both tests will drill to 6,200 ft., and both are in W. T. Sadler Survey, A-867.

Monsanto Chemical Co. has staked location for 2 Nannie 1 mile northeast of Slocum townsite. Location for the 6,000-ft. test is northeast of No. 1, in Allen Killough Survey, A-469.

S.E.G.'s Midwest Meeting Scheduled for March

The tenth annual midwestern meeting of the Society of Exploration Geophysicists has been scheduled for March 13, 14, and 15, 1957, at Hotel Texas in Fort Worth, according to Howard Itten, general chairman.

Itten is president of Empire Geophysical, Inc., and currently heads the Fort Worth Geophysical Society, host to the meeting and cosponsor with the Dallas Geophysical Society, Ark.-La.-Tex. Geophysical Society, in Shreveport, Geophysical Society of Oklahoma City, Permian Basin Geophysical So-

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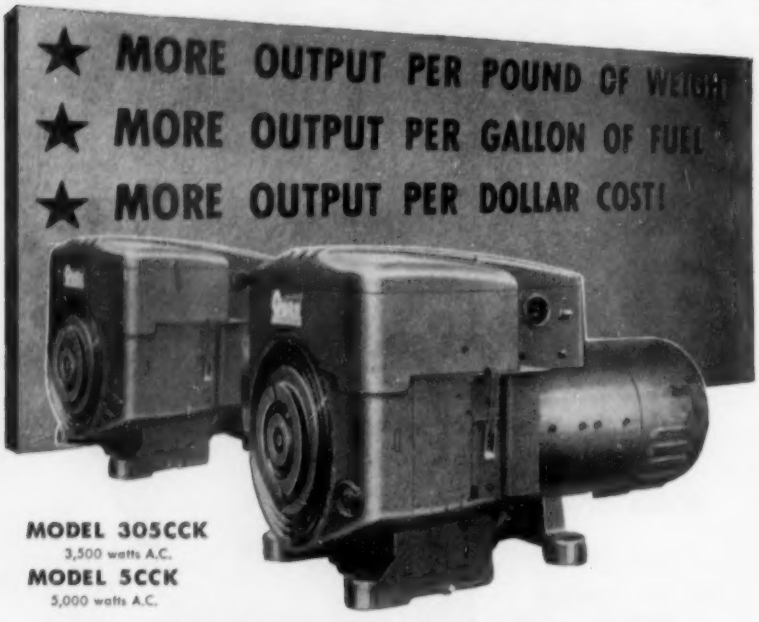

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ciety in Midland and the Geophysical Society of Tulsa.

Itten said this meeting, held on alternate years in Dallas and Fort Worth, is the largest regional conclave of the S.E.G. with an attendance of more than 1,000 oil exploration geophysicists. It attracts earth scientists not only from the oil-rich Southwest, but from many other parts of the world, Itten reported.

WEST TEXAS-NEW MEXICO

WEST TEXAS

First Test Started on Pecos County Block

Stanolind Oil & Gas Co. 1 University "CS," a 17,000-ft. project, is the first exploratory test to be made on the firm's 3,840-acre drilling block obtained in the June 1956 lease sale. Purchase price was $4,250,000.

Location of the wildcat is in 27-23-University Lands Survey. The drilling block comprises all of Section 16, Section 21, northwest quarter of 22, south half of 22, west half of 26, all of 27, east half of 28, north half of 34 and northwest quarter of Section 35, in Block 23, University Lands Survey, 15 miles southeast of the town of Fort Stockton.

Terry County Well Flows Devonian Oil

West Central Terry County gained another Devonian strike at The Texas Co. 1 Allean C. Black. Location is in Section 123, Block D-11, C&M Sur-

THE TEXAS CO. 1 Black, discovery in Terry County, made a heavy flow of oil on initial test of the Devonian.

vey, 9 miles north and slightly west of Wellman.

On production test through 1-in. choke, 1 Black flowed 202 bbl. of new oil, plus 49 bbl. of load oil in 8 hours. Perforations were in the Devonian from 12,783-98 ft. Gravity and pressures were not reported.

Top of the Devonian was 12,766 ft., or minus 9,364 ft. A previous drill-stem test, covering the entire Devonian section drilled, or from 12,670-12,801 ft., did not flow but recovered 63 bbl. of oil in the pipe. Flowing pressure ranged from 1,215-4,345 psi.

Location of the Texaco discovery is about midway between South Coroco field, which has one well in the Devonian at 12,742 ft., and Northwest Wellman, which found Devonian oil at 12,763 ft.

Big Gasser Completed In Puckett Field

Phillips Petroleum Co. has announced official completion test at its 2 Evelynjo in the Puckett field, Pecos County. Location of the well in 40-101-TCRR Survey is on the southwest flank of the field, and adds a new pay to that immediate area.

Potential was calculated at 370,000,000 cu. ft. of gas a day, based on production tests made in August. Pay was the Devonian, perforated at 10,355-10,462 ft., total depth.

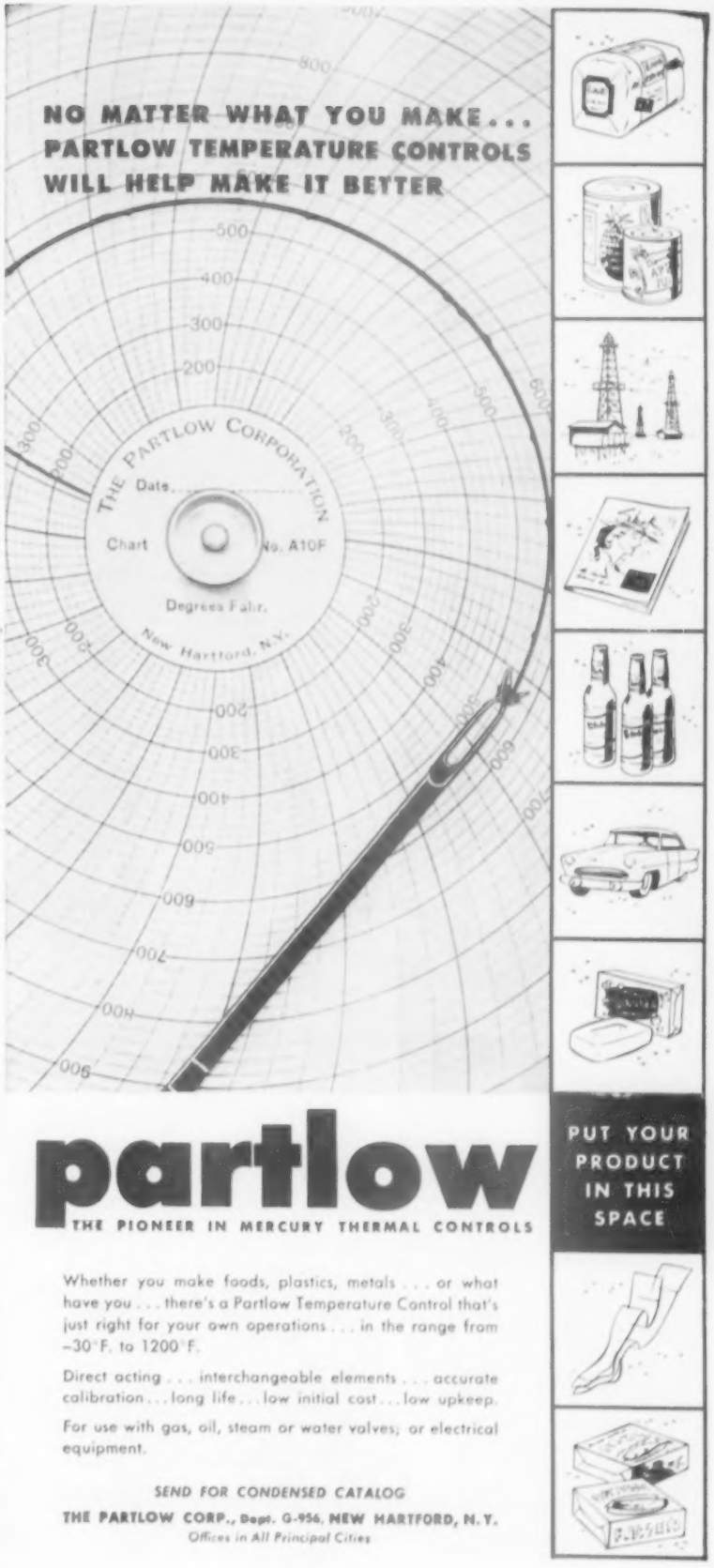
On the northern side of Puckett field, Gulf 1 Jerusha Robbins "A" has been completed, after many months of testing. Calculated open-flow potential was 23,000,000 cu. ft. of gas a day from the Ellenburger at 12,430-12,836 ft. Shut-in pressure was 4,378 psi.

Early this year Phillips 1-A Robbins had the prospects of Devonian oil production, then blew out while still in the Devonian, making an estimated 50,000,000 cu. ft. of gas a day. Operators killed the flow and drilled ahead.

First Fusselman Oil In Borden County

Borden County gained its first Fusselman discovery at J. D. Wrather, Jr. and Republic Natural Gas Co. 2-16 T. J. Good, in 16-32-T3N-T&P Survey, 15 miles southwest of Gail. The well flowed 205 bbl. of oil a day through 18/64-in. choke, from perforations at 9,805-15 ft.

Nearest Fusselman production is in Big Spring field, Howard County, 15 miles to the southeast. Operators of the new strike planned to re-enter the 2-16 Good for further acid treatment before putting it on production.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Spraberry Well Flows

Advance Petroleum Co., Dallas, has completed its 1 William Howard as a lower Spraberry sand discovery in southwestern Glasscock County. Potential was 435 bbl. of oil a day through ½-in. choke, from perforations at 7,350-57 ft. Operators drilled to 7,389 ft., ran casing to bottom and fractured the formation.

Location in Section 29, Block 35, Township 5 South, T&P Survey, is 16 miles south of Garden City, and about 2 miles east of Spraberry production in the Trend fields.

SOUTH LOUISIANA

New Production Opened in Two Boullion Discoveries

Two additional wells were completed at the old Bayou Boullion dome on the St. Martin-Iberville Parish line, last week. One, a deep gas-condensate well, extends production on the north side of the dome 2 miles northwestward and outward. It is on the St. Martin side of the line. The other opens a new reservoir on the northeast side, in Iberville Parish.

The northwest extension well was drilled by Sohio Petroleum Co. and Howell, Holloway & Howell. It is completed from perforations at 12,958-62 ft. and 12,968-72 ft. in hole bottomer at 13,701 ft. The well, after cleaning, was shut-in without gaging pending potential tests and provision of a market outlet.

The new reservoir was opened by Glassell & Glassell at 1 Cotton, completed with a flow of 56 bbl. of 26.5°-gravity oil per day from perforated interval at 6,444-91 ft. Total depth is 7,365 ft.

15,000-Ft. Sand Produces In St. Martin Discovery

Production at depth below 15,000 ft. has been proved in another South Louisiana discovery.

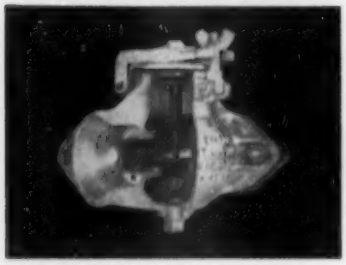
The discovery opens an entirely new field, located on the St. Martin-Lafayette Parish line, 3 miles southeast of Broussard.

The discovery well, drilled by Richardson & Bass to 16,606 ft., is productive from perforations at 15,024-34 ft., 15,054-59 ft., and 15,076-85 ft.

Flow through 7/64-in. choke was at the rate of 61 bbl. of 48.3°-gravity distillate with 3,310,000 cu. ft. of gas per day. Flowing pressure was 6,900 ft.

The well is the operators' 1-A Tidewater-Fremin and Petro Unit. Location is 4½ miles southwest of St. Martinville field, nearest production.

Enardo 1900 Series In-Line Vent Valve



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Are you still looking in the sky for profit losses? Enardo Vent Valves provide a means of keeping a predetermined pressure on stock tanks. These vent valves are used in conjunction with Enardo pressure type hatches. Set 2 to 4 ounces less than hatch pressure to prevent hatch venting.

On leases not using a positive venting system, that have changed to an Enardo Vapor Control System, it has been proven that there was an immediate increase in saleable fluid gravity. For, on a lease with a production of 50 barrels per day, it is possible to add a total savings of $1,482.00 in the books after the installation of proper hatches and vent valves, cutting gravity and volume loss.

Enardo 800 series Vent Valves are offerred in standard 2", 3" and 4" pipe sizes, pressure settings ½ to 16 ounces. Featuring aluminum or semi-steel bodies with plastic trim. Slip-On or flanged ends. Standard valve is 1 ounce pressure, 4/10 ounce vacuum.

Enardo 1900 series Vent Valves also offered in 2", 3" and 4" sizes, with or without companion flanges bolted on. Standard valve 2 ounce pressure, 4/10 ounce vacuum. Pressure settings from 2 to 24 ounces.

Contact the representative nearest you for further information.

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SOUTH TEXAS

TEXAS GULF COAST

Jackson County Wildcat Records Large Gas Flow

Open-flow potential of British Texas Oil Co.'s new discovery-well 5 miles east of Ganada, in eastern Jackson County, near the Wharton County line, is rated at 100,000,000 cu. ft. of gas per day. The gas yields a 51.9°-gravity condensate in the ratio of 210,000 cu. ft. of gas per barrel of liquid. Shut-in pressure is 2,329 psi. Production is from a Frio sand, perforated at 6,017-27 ft. Total depth is 6,838 ft. Nearest production is in East Ganada field, 4 miles southwest. The well, 1 Heard, flowed at the rate of 2,300,000 cu. ft. of gas per day through 5/32-in. choke with pressure of 2,249 psi.

Milton Opens Deeper Pay

J. S. Abercrombie is opening a new pay-zone in the Milton area, north of North Houston, in Harris County. Discovery well, 5 Weisenberger, is per-

forated in it at 6,939-41½ ft. Other production in the area is from a 6,675-ft. sand. The new well flowed 1,159,000 cu. ft. of gas and 15.15 bbl. of condensate per day on tests through 5/32-in. choke. Flow pressure was 2,089 psi. Hole was drilled to 7,001 ft.

SOUTHWEST TEXAS

New Oil Area Opened in Starr County Discovery

A new oil-productive area, located 8 miles north of Rio Grande City, in Starr County, is being opened by Wood Brothers and Langham at their 1 Garcia, completed with a flow of 66.22 bbl. of 47.4°-gravity oil per day from perforations at 3,661½-64½ ft. Flow was through ⅛-in. choke with pressure of 24 psi. Location is 2 miles northwest of Ross field, nearest production, and about 4 miles northeast of Zim field.

Another new discovery in Starr County is being confirmed. It is the East Cameron field, 20 miles northeast of Rio Grande City. Confirmation is by Farenthold & Pitcairn at their 2 Cameron, 2,600 ft. northeast of their discovery well (1 Cameron), completed for 3,550,000 cu. ft. of gas (open-flow potential) from perforations at 3,190-95 ft. The second well is rated at 4,450,000 cu. ft. daily in the same pay. Location also is about 12 miles northwest of McCook townsite.

Webb County Wildcat Completed as Gasser

Killam & Hurd's new discovery well 8 miles southwest of Aguilares, in southeastern Webb County, is rated good for 1,460,000 cu. ft. of gas per day with liquid recovery in the ratio of 1 bbl. to 81,300 cu. ft. of gas. Gravity of the liquid is 45°. Pay is perforated at 4,946-56 ft.

The well, 1 Bruni-Leyendecker estate, was drilled to 5,778 ft. by Texas Gulf Producing Co. and others. Present operators plugged back to 5,770 ft.

SOUTHEASTERN STATES

MISSISSIPPI

Wilcox Sand Produces In Another Adams Discovery

Wilcox sands are proving productive in another Adams County discovery.

A wildcat drilled by Calto-Gulman-Callon in the southeast corner of the county, in southwestern Mississippi, pumped 121 bbl. of 39.5°-gravity oil

Leschen's quick-fact-finding Service-Score System utilizes easily applied, easily removed pressure sensitive stickers, which record equipment and rope data, dates of rope installation and removal.

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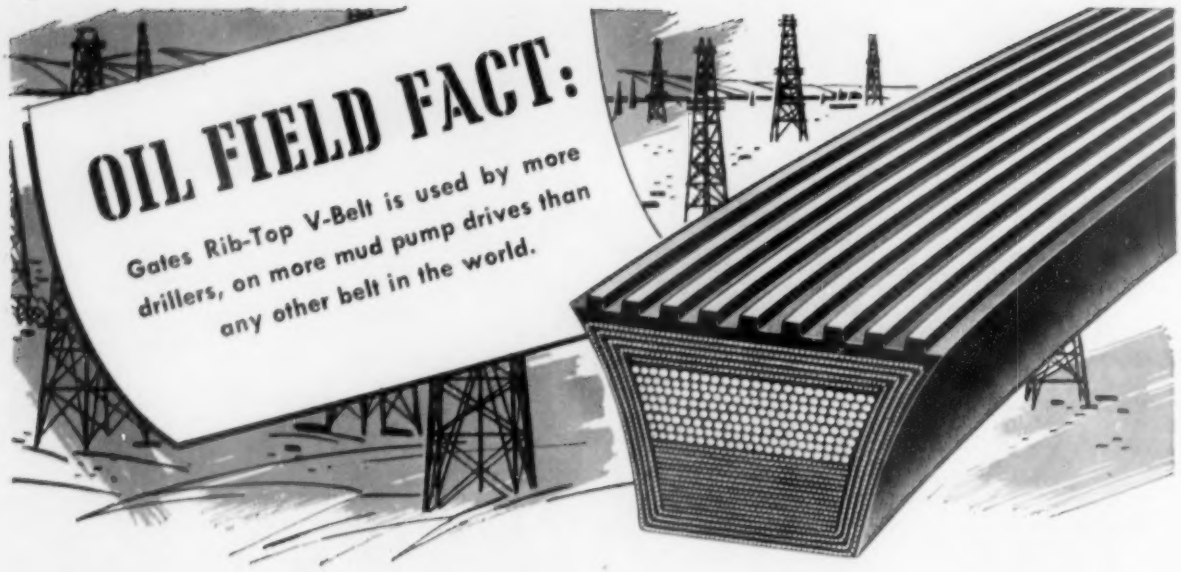

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Both Standard and Super Rib-Top V-Belts are available from your oil field supply house. You pay no more for Rib-Tops than for ordinary belts of comparable ratings. Specify Gates Rib-Tops next time you order. The Gates Rubber Co., Denver, Colorado—*World's Largest Maker of V-Belts.*

Use Super Rib-Top for Toughest Drives

40% greater horsepower capacity. Easily handles drive overloads. Fewer belts and narrower sheaves solve space and weight problems.

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Straight-sided belts bulge at the sides when bent. Uneven contact (Fig. B) causes uneven wear, shortens belt life.

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TPA 85

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DEVELOPED ESPECIALLY FOR MUD PUMP DRIVES

per day from the Minter zone, perforated at 6,652-54 ft.

Discovery well is their 1 Drane, in 20-5n-1w. The new area is designated as Deerfield field, after the plantation on which the well is located.

NEW MAP

ROCKY MOUNTAIN MAP. Published by Rocky Mountain Association of Geologists. Sales agent, Petroleum Information, Box 2612, Denver. Two sheets 38 by 44½ in. $2.50.

With a scale of 1 to 48,000 or about 1.3 in. per mile, this new map displays formation boundaries, dips and strikes, faults and folds, drainage and culture. This new map should be useful particularly to people interested in the geology of the west side of the Denver basin. Some of the folds and other structural trends bordering the Front Range are studies of importance to the oil-finder.

Successful Wildcats

ALBERTA

Honolulu et al 16-17 Paddle River, LSD 16, 17-56-8w5. TD 5,391 ft., Mississippian oil well.

White Rose Supertest 10-7 South Duhamel, LSD 10, 7-45-21w4. TD 4,891 ft. D3 oil well.

T.G.T.-Mobil-C.P.R. 26-1 Chancellor, LSD 11, 26-25-21w4. TD 5,150 ft. Basal Colorado gas well.

SASKATCHEWAN

Hu Sky-Mic Mac-Can Superior 1, Hutoon, LSD 7, 33-6-10w2. TD 4,542 ft. Mission Canyon oil well.

Gridoil 10-25 Auburton, LSD 10, 25-4-2w2. TD 4,270 ft. Mission Canyon oil well.

ILLINOIS

Christian County: Melvin Fesser 1 Orlandini, SW SE SE 13-13n-4w. IPP 25 BOPD, Silurian 1,858-70 ft., 39.6°. TD 1,870 ft. (Oil discovery of Sicily field.)

KANSAS

Barber County: Elwool pool opened by Petroleum, Inc., 1 Roberts, NE NE SW 34-34s-13w. Completing in Elgin sand. TD 4,910 ft.

Barton County: East St. Peter pool opened by Nadel & Gussman 1 Johanning, NW SE SW 34-18s-11w. Completing in Lansing. TD 3,401 ft.

North Workman pool opened by Petroleum, Inc. 1 Hulme "I," NW SW SE 16-20s-12w. Completing in Lansing. TD 3,465 ft.

Chautauqua County: Northwest Howins pool opened by Glick 1 Harvey, SW SW SW 27-34s-9e. IP 196 M.c.f. gas per day, Mississippian. TD 2,453 ft.

Cowley County: North Albright pool opened by CRA 1 Brown "A," SE SE NE 34-33s-5e. Completing with total depth 3,129 ft.

North Walnet Bend pool opened by Richard King 1 Mueller, NE NW SW 36-33s-4e. IPP 5 BOPD, Mississippian. TD 3,223 ft.

Ellis County: West Schoenschen pool opened by Elreco 1 Roth, SW SW NW 21-15s-18w. Completing in conglomerate. TD 3,654 ft.

Finney County: Sequoyah pool opened by

SAVED $126,360.00

REPLACEMENT COSTS ON 28,430 FEET OF PIPELINE

In August of 1953, Internal Pipeline Maintenance Company internally coated 15,430 feet of badly deteriorated 8" Naylor spiral weld pipe. Part of a 28,430-foot pipeline connecting a gasoline plant and a carbon black plant, this line, transporting sour residue gas, was in such critical condition that the problem became a question of deciding between replacing the entire line with new pipe or internal cleaning and coating so that operations could be continued.

It was decided to clean and coat the line, and that the coated section would be considered a test of the IPM process.

By April of 1955, results on the 8" section had proved so satisfactory that it was decided to coat the remaining 13,000 feet. This section was made up of 12" Naylor spiral weld pipe.

The entire cleaning and coating operation was completed at a total cost of only $23,640.00. Cost of replacement with new 10" pipe was estimated in excess of $150,000.00.

Not only has the coating given trouble-free service, but it eliminated entirely the need for replacement. By calling in IPM, the operator realized an outright saving of $126,360.00—in addition to savings in maintenance.

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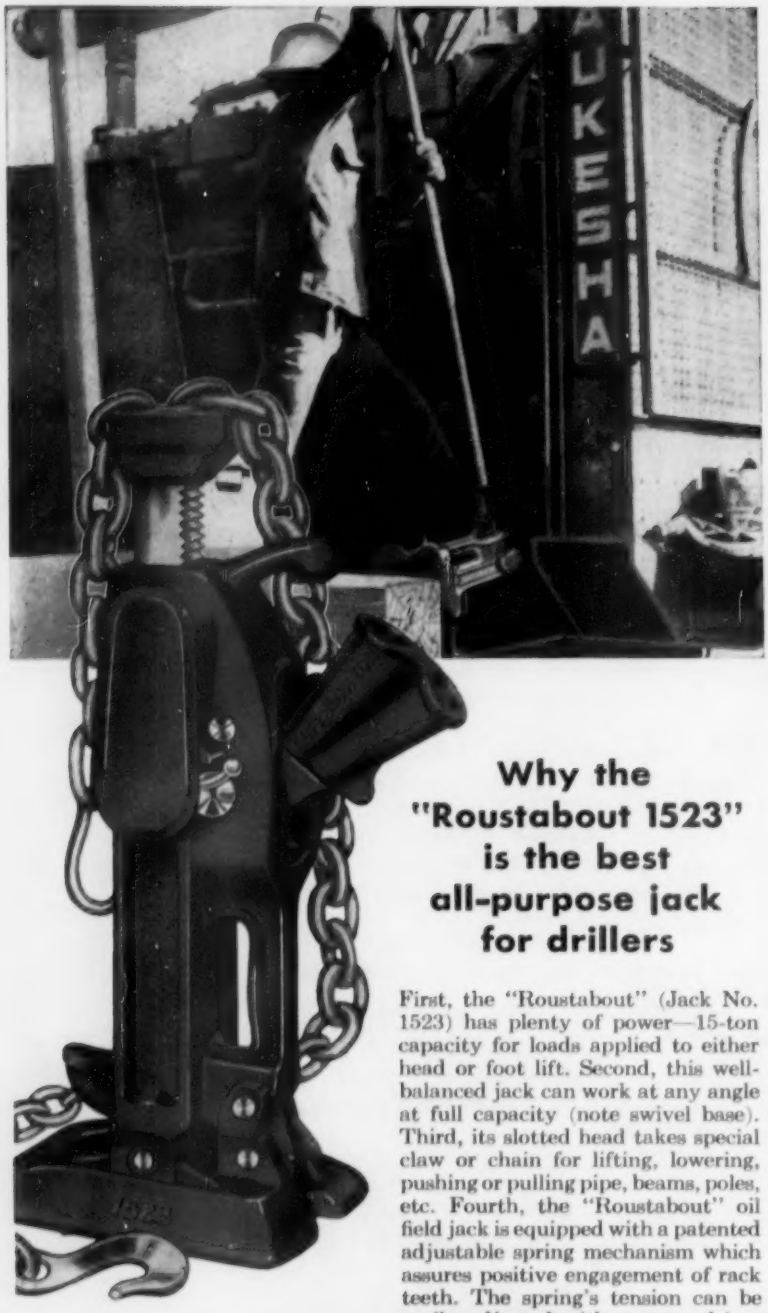

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"Giving Industry A Lift Since 1883"

Champlin Refining Co. 2 Leavitt, C SW NE 17-23s-34w. Completing in Morrow sand.

Graham County: Brassfield pool opened by Fortier & Brown 1 Brassfield, NW NW NE 2-10s-22w. Completing in Lansing. TD 3,934 ft.

Hatcher pool opened by Jones, Shelburne & Farmer 1 Hatcher, NW NE NE 6-9s-21w. Completing in Arbuckle. TD 3,730 ft.

McPherson County: East Harmac pool opened by Time Petroleum Co. 1 Waltner, NW SE SE 36-21s-3w. IPP 10 BOPD, Hunton lime. TD 3,530 ft.

Meade County: Angell pool, opeuend by Sinclair 1 Angell, C SE SE 30-32s-29w. Completing in Mississippian. TD 5,783 ft.

Russell County: Worley pool opened by Western Development Co. 1 Worley, NW NW NE 4-11s-15w. IPP 5 BOPD, Lansing. TD 3,421 ft.

Sedgwick County: Northwest Brumley pool. Opened by Beardmore Drilling Co. 1 Smith, SE SE SW 12-29s-1w. Completing in Mississippi. TD 3,315 ft.

Trego County: Page Creek pool opened by Century Refining Co. and K&E Drilling Co. 1 Tipton Est., SE SE SE 28-15s-22w. Completing. TD 4,338 ft.

KENTUCKY

Christian County: Mrs. J. B. Whitebread 1 Parker, SE NE SW 10-F-25. IPP 7 BOPD, Benoist sand 387-410 ft. TD 772 ft. Opens Kelly field.

MICHIGAN

Gladwin County: Sun Oil Co. 1 Linaberry, NE NW SE 10-18n-2w. AIP est. 25-30 bbl. oil, plus water, from Richfield pay 5,026-73 ft. TD 5,228 ft., PBTD 5,095 ft. (New, deeper pay in abandoned Grout Dundee pool).

MISSISSIPPI

Adams County: Calto - Gulmon - Callon 1 Drane, 20-5n-1w. IPP 121 BOPD, 39.5°, perforations 6,652-54 ft. (Wilcox). TD 7,010 ft.

NEBRASKA

Banner County: Shell Oil Co. 2 Mosier "B," C SE SW 21-19n-53w. IPP 140 BOPD, "J" sand discovery, new field. TD 4,838 ft. "D" sand.

Kimball County: Chandler-Musgrove et al 1 Rodman, C NE NW 27-15n-55w. IPP 239 BOPD, "J" sand discovery, new field. TD 6,175 ft. Skull Creek.

SOUTH LOUISIANA

Plaquemines Parish: Union Producing Co. and Sohio Petroleum Co. 2 Tambour et al, 29-22s-31e. IP 130 BOPD, ⅛-in., 26.1°, perforations 10,675-79 ft. TD 11,176 ft. (New field).

NORTH TEXAS

Archer County: Akin & Dimock 3 Vieth, Sec. 60, Blk. 3, Clark & Plumb, 2½ miles S Scotland, new pay discovery. IP 165 BOPD, ¼-in., TP 325 psi., 43°, GOR 530, Vogtsberger sand 4,498-4,530 ft. TD 5,133 ft.

Texoma Drilling Co. 3 Parkey, Blk. 1, SPRR Sur., A-423, 3 miles SE Mankins, new pay discovery. IPP 50.5 BOPD, 40°, GOR 500, Gunsite 1,726-34 ft. TD 1,750 ft.

Baylor County: L. & H Drilliing Co. and associates 1 Poe, David Barlow Sur., A-10, Blk. 193. IPP 124 BOPD, 36°, GOR 100, pay 1,416-21 ft. TD 1,550 ft.

Grayson County: British-American Oil Producing Co. 1 Degan, B. S. Nounan

Sur., A-903, 3 miles E Tioga. IPP 158 BOPD, 34.5°, GOR zero, pay 3,802 ft. TD 4,310 ft.

Jack County: Standard American Producing Co. 1 Sewell, John W. Buckner Sur., A-34, ½ mile S Jacksboro. IP 14,000 M.c.f., open flow, plus 15½ bbl. condensate, Atoka conglomerate 5,072-85 ft. TD 5,294 ft.

Young County: Fletcher Oil & Gas Drilling Corp. 1 Stasney-Jones, Sec. 349, TE&L Sur., 8 miles NW Newcastle. IP 55.6 BOPD, 12/64-in., TP 190 psi., 41°, GOR 432, Mississippian 4,778-82 ft. TD 4,790 ft.

SOUTHWEST TEXAS

Jim Hogg County: Cotton & Blair Vreeland 2 Yeager, South Portion of Survey 108. IPP 40.53 BOPD, 39.6°, perforations 3,143-48 it. TD 3,188 ft. (New reservoir in Stroman field—designated as East Yeager field).

TEXAS GULF COAST

Chambers County: Dan J. Harrison, Jr., et al 1 Wilborn et al, Williams Moore Sur., A-186. IP 335,000 M.c.f. daily, open-flow potential, GOR 30.4 M.c.f. per bbl., 56.8°, perforations 9,305-13 ft. TD 9,900 ft. (New field).

San Patricio County: Melba Production Co. 1 Stiba, Lot 6, Sec. 23, Second Addition Taft Farm Lands. IP 124 BOPD, ⅛-in., 31°, perforations 5,592-96 ft. TD 5,602 ft. (New field.)

WEST CENTRAL TEXAS

Shackelford County: Geochemical Surveys 1 Davis, 45-13-T&P, 15 mi. SW Albany. IP 35 BOPD, 30/64-in., TP 350 psi., 42°, GOR 1850, Gardner sand 3,913-17 ft. TD 3,990 ft.

Stephens County: Texota Oil Co. 2 C. K. West, 11-3-SPRR, 7 mi. N Caddo. IP 2,900 M.c.f., open flow, conglomerate 3,883-3,904 ft. TD 4,006 ft. Tubing pressure 1,000 psi. on 18/64-in. choke.

Wittmer-Knight-Ewing 1-B Ila Norvell, Sec. 76, BAL Sur., 9 mi. SW Breckenridge. IP 96.8 BOPD, 10/64-in., TP 775 psi., 39°, GOR 1870, pay 3,319 ft. TD 3,797 ft.

WEST TEXAS

Andrews County: Humble Oil & Refining Co. 1 Armstrong, 11-A45-PSL, 7 miles NE Andrews, Wolfcamp pay discovery in South Means field. IP 227 BOPD, ⅝-in., TP 1,050 psi., GOR 732, 40°, perforations 9,378-9,414 ft. TD 14,166 ft. Ellenburger top 13,943 ft., elev. 3,153 ft.

Garza County: W. M. and A. P. Fuller 2-A Fuller, 112-5-H&GN, 5 miles SE Justiceburg. IPP 69 BOPD, 36°, GOR 250, San Andres 1,904-14 ft. TD 2,083 ft.

Howard County: Phillips Petroleum Co. 2 Johnnie "B," 7-31-T1N-T&P, Canyon reef discovery in Big Spring-Fusselman field. Reef potential 66 BOPD, pumping, perforations 8,746-70 ft. GOR 148, 44°. TD 9,575 ft. Dual completion.

WEST VIRGINIA

Tucker County, Licking district: Hope Natural Gas Co., 9993 Earl Fike, elevation 1,921 ft., 8,200,000 cu. ft. gas, after fracture, chert 4,684 ft., gas 4,800 ft., Oriskany sand 4,916 ft., gas 5,018-5,021 ft. TD 5,192 ft.

WYOMING

Sweetwater County: Mountain Fuel Supply Co. 1 UP, NW SE SE 23-20n-104w. IP 7,000 M.c.f. of gas per day, Dakota discovery, new field. TD 4,587 ft. Nugget.

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If overloaded, "safety valve handle" will bend before any other part of hoist fails.

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Magnolia's Clewell proved . . .

. . . Physicist Won Spot in Oil

TWENTY years ago, if asked where he could use a physicist, an oil-company executive probably would have asked "What's a physicist?"

The times have changed. From a nonsought-after luxury, the physicist has become a necessity. He can be and is used in all oil-industry divisions.

Now a major oil company has placed one in charge of all its research laboratories. He is Dr. Dayton H. Clewell, who has been manager of Magnolia Petroleum Co.'s field research laboratories in Dallas since 1952.

Dr. Clewell will move to New York around the first of October to take over direction of all research labs operated by Socony Mobil Oil Co., Magnolia's parent firm.

Clewell, 43, was born in Berwick, Pa., and went through grade and high school there. He entered Massachusetts Institute of Technology in 1929 and graduated with a B.S. in physics in 1933 in the height of the depression. Demand for physicists then was nil.

Clewell stayed on at M.I.T. to work for his doctorate, meeting his expenses with income from a job as general news reporter for the Boston Globe. He was awarded his Ph.D. degree in physics in 1933 and went to work for C. K. Williams Co., Easton, Pa.

Sees opportunity . . . Clewell was still with the Williams firm in 1938 when Magnolia began looking for a man to develop a gravity meter. These exploration instruments, then brand new, were at that time being developed individually by the various oil companies. Magnolia went to M.I.T., Clewell's name was mentioned by the institution as a possibility, and he was offered a job.

He took it. Coincidentally with his move to Dallas later in 1938, Clewell married the former Jean Rapp of Boston, a student at the Sargent School of Physical Education, now a part of Boston University.

Clewell, as a member of Magnolia's geophysical department, developed the gravity meters now used by the company. In 1942 he was transferred to the field research laboratories as supervisor of physical research. In this position, he supervised four newly organized research groups in geophysics, geochemistry, chemical physics of catalysis, and electronic instrument development.

When process and product research efforts were moved from Dallas to Paulsboro in 1946, oil exploration research was accelerated at Dallas and formal production research started. Clewell became supervisor of the newly organized exploration research division and later was named assistant director of the lab.

Active in oil groups . . . Clewell, besides his work for Magnolia, has given generously of his time and talent to research programs of the various industry associations.

He was chairman of the American Petroleum Institute's Project 43 (Transformation of Organic Material into Petroleum) for several years and also of a special reviewing committee on geophysics. He is a member of the A.P.I. advisory committee on fundamental research on the occurrence and recovery of petroleum. He chairmans the research committee of the Society of Exploration Geophysicists and is a trustee of the research fund of the American Association of Petroleum Geologists.

Along with this, he acted as chairman the past 2 years of the special-weapons defense committee of the Dallas County Civil Defense and Disaster Commission. This group is charged with analyzing conditions and recommending action in case of bacteriological, atomic, or chemical types of attack.

Clewell's spare time is understandably limited. He likes to use what he has "messing with electronics and color photography." Son Don, 15, is a ham radio operator, and he and dad often collaborate in building tiny transistor radios. The Clewells have one other child, Nancy, 14.

Personals

W. P. Binger, mechanical engineer with Shell Oil Co., has been transferred from Wichita to Centralia, Ill.

Berry M. Johnson, a recent graduate of the University of Texas, has joined Stanolind Oil & Gas Co. as a junior petroleum engineer at Andrews, Tex.

Dupree (Dutch) Ingram, gang pusher for Skelly Oil Co. at Plainville, Kans., has been promoted to local foreman and transferred to Chase, Kans.

Elzie Wolker and **Quentin R. Jeffries** have joined the engineering staff of Commercial Solvents Corp. at the company's Terre Haute, Ind., research and production center.

Glenn Hager, geologist for Continental Oil Co., has been named assistant division geologist at Ardmore, Okla. In other promotions, **Wesley Bird,** geophysicist for the company, has been appointed division geophysicist at Wichita.

Richard C. Frawley has resigned as exploration superintendent of Sinclair Oil & Gas Co.'s West Texas division at Midland, Tex., after 23 years of service with the company. He had held his most recent position since the West Texas division was formed in April.

W. S. Dulaney has been appointed Continental Oil Co. division manager at New Orleans. DuLaney was formerly district manager at Corpus Christi, Tex. **Arch Baillie,** assistant district manager in Corpus Christi, will succeed DuLaney as district manager there. **J. P. Logan,** assistant district manager at New Orleans, will become assistant division manager in that area.

E. A. Ramsay, Consolidated Peak Oils, Ltd., has been elected president of the Lloydminster (Alta.) Petroleum Association. **A. W. Kissack** of Nuco Petroleums, Ltd., has been named vice president of the group. Named as directors were **L. E. Pearson,** Nuco Petroleums, Ltd.; **O. C. Yates,** Lloydminster Gas Co., Ltd.; **N. Cyprus,** North American Oils, Ltd.; **H. T. Phillips,** P.A.T. Operators, Ltd.; **A. W. Fleming,** Excelsior Refineries, Ltd.; **E. E. Wagner,** North American Chemicals, Ltd.; **Arthur Jones,** Lloydminster Development Co., Ltd.; **A. E. Mock,** Consolidated Peak Oils, Ltd.; **D. A. Cleal,** Lloydminster Gas Co., Ltd.; and **Clare Ross,** C. P. Ross Oil Well Servicing.

Personals

H. P. Rigsby, technical services representative in Houston for Continental Oil Co., has been transferred to San Antonio, Tex., as district manager.

Richard L. Robinson, drilling engineer with Standard Oil Co. of Texas, has been transferred from Gainesville, Tex., to Houston as reservoir engineer.

F. B. Inks, Jr., production engineer with Gulf Oil Corp., has been transferred from Heidelberg, Miss., to Harvey, La., as drilling engineer.

Don R. Holbert, petroleum engineer with Sinclair Research Laboratories, Inc., has been transferred from Nowata, Okla., to Tulsa.

Gilbert Wood, Jr., manager of the economics department of Frankfort Oil Co., Bartlesville, Okla., has been promoted to manager of the company's Gulf Coast division and transferred to New Orleans.

William M. Martin, executive vice president of Russell Cobb, Jr., Inc., Tulsa oil-producing firm, has resigned. Martin will continue to work with the Cobb organization as an independent.

E. V. Corps, exploration manager for Pakistan Petroleums, Ltd., in Karachi, has retired after 26 years with the oil industry in the East. Corps joined Burmah Oil Co. in 1930 as a geologist. He has been exploration manager of Pakistan Petroleum since 1953.

N. D. (Polly) Clark, independent, and **J. R. Dirks,** formerly of Phillips Petroleum Co., have formed their own consulting geological firm in Wichita. Clark was previously with Trans-Western Oil, Ltd., Lion Oil Co., and John Lindas Oil, Inc. Dirks was with Halliburton Oil Well Cementing Co. before joining Phillips.

E. W. Bergquist, assistant district superintendent of Interstate Oil Pipe Line Co.'s Magnolia, Ark., district, has been appointed acting district superintendent at Billings, Mont. He replaces **Hermon S. Foote,** who has been granted a leave because of illness. **K. G. Smith,** district foreman in Interstate's Brookhaven, Miss., district, will succeed Bergquist at Magnolia.

W. C. Lane, assistant manager of Standard Oil Co. of California's foreign trade department, has been appointed manager. He succeeds **J. E. Black,** who has retired.

D. L. Ziegler, geologist for The California Co. at Bismarck, N. D., has been transferred to Hardin, Mont. **Cyril Harvey** will succeed Ziegler at Bismarck.

Homer D. Austin, reservoir engineer with Phillips Petroleum Co. at Shidler, Okla., has been promoted to assistant superintendent and transferred to Pauls Valley, Okla.

A. J. Oden, seismic interpreter with Magnolia Petroleum Co. in Dallas, has been named district geophysicist and transferred to the company's new Oklahoma City office.

John Woncik has been named Oklahoma district geologist for Apache Oil Corp. with headquarters in Tulsa. Woncik was with W. C. McBride, Inc., before joining Apache, in 1955.

Thomas N. Duncan has formed a new drilling firm, the N. V. Duncan Drilling Co., in Fairfield, Ill. Duncan will be president of the company. **Mrs. Lesta C. Duncan** has been named vice president and **Paul Duncan,** secretary-treasurer.

Robert G. Hawley, vice president of Big West Oil Co. of Montana, has been elected president and general manager of the company succeeding his father, Lloyd R. Hawley, who died August 21. The younger Hawley joined Big West in 1939.

Howard D. (Deep) Henderson, former coordinator of foreign operations for Sohio Petroleum Co., has joined Trunkline Gas Co. of Houston as manager of production and supply. Henderson was previously with White Eagle Oil & Refining Co., Skelly Oil Co., and Continental Oil Co.

F. F. Deaver, assistant manager of crude oil and volatiles for Shell Oil Co. in New York, has been named manager of the company's Houston crude-oil department. He replaces **O. D. Crites,** who is retiring after 31 years with Shell. Crites has been manager of the Houston department for the past 20 years. **E. L. Blinn,** assistant manager of the Houston crude-oil department, will replace Deaver as assistant manager in New York. **J. K. Moore,** supervisor of crude oil in Houston, will move up to Blinn's position as assistant manager.

R. J. Maberry has joined Fryer & Hanson Drilling Co. in Midland, Tex., as contract representative.

H. E. LINAM

Henry E. Linam has been named chairman of the Cuban Venezuelan Oil Voting Trust succeeding **Warren W. Smith,** who has retired. The trust is a management organization for the 24 Cuban companies which hold concession rights over approximately 15,000,000 acres in the area. Linam was president of the old Standard Oil of Venezuela from 1932 to 1943.

George R. Dillon has been named chief geologist of the Arkansas Western Gas Co. at Fayetteville, Ark.

Grover Ledlie, vice president and general manager of Rogers Oil Co., has resigned to open petroleum consultant offices in Denver.

Lyle C. Nelson, formerly with the mechanical engineering department of Shell Oil Co., has joined Arrowhead Exploration in Denver.

K. T. Johnson has been promoted from district manager to division manager at Continental Oil Co.'s Houston office. Also in Conoco's Houston office, **Bill Biggerstaff** will advance from assistant district manager to assistant division manager.

Frank R. Holtzapple, assistant division superintendent in Phillips Petroleum Co.'s central division, has been appointed superintendent of the company's new Guymon district, Guymon, Okla. **G. I. Freeze,** assistant district superintendent at Pauls Valley, Okla., will be assistant superintendent in the new district.

Audley L. Bailey, president of Canfield Oil Co., a subsidiary of Standard Oil Co. (Ohio), for the past 11 years, is retiring after 43 years with Canfield. Bailey is a director of the Pennsylvania Grade Crude Oil Association, a trustee of the National Petroleum Association, and a member of the A.P.I.'s 25-year club.

Joseph J. Lawnick, petroleum engineer for La Gloria Oil & Gas Co. at Corpus Christi, Tex., has been promoted to assistant chief engineer. **T. L. Cooper,** field superintendent for the company, has been transferred from Luling Tex., to Marshall, Tex.

James R. Moyer, geologist for Sun Oil Co. in San Antonio, Tex., has joined Mayfair Minerals, Inc., as district geologist at McAllen, Tex.

David C. Pontius, exploitation engineer with Shell Oil Co., has been transferred from Los Angeles to Ventura, Calif.

Joseph C. Scherer, division petroleum engineer with Union Pacific Railroad Co., has been promoted to assistant chief petroleum engineer and transferred from Rock Springs, Wyo., to Los Angeles.

Stanley A. Beck, exploitation engineer with Shell Oil Co. at Ventura, Calif., has resigned to join Honolulu Oil Corp. as a petroleum engineer at Taft, Calif.

Jerry Van Norman, field man and pusher for Basin Contractors at Fort Morgan, Colo., has joined Lawrence Drilling Co. as cable-tool driller at Farmington, N. M.

David S. Johnson has joined the North Dakota Geological Survey at Grand Forks, N. D. He replaces **John L. Hainer,** who has resigned. Johnson is a recent graduate of the University of Minnesota.

William H. Craddock has been named superintendent of Shell Pipe Line Corp.'s Wasson, Tex.-Hobbs, N. M., division at Hobbs. He replaces **S. B. Bean,** who has been transferred to Port Neches, Tex., as superintendent of Shell Pipe Line's Bayou division.

LaRue K. Ebersole, corrosion engineer with Colorado Interstate Gas Co. in the Panhandle field near Amarillo, Tex., has been promoted to electrical engineer and transferred to Colorado Springs.

Marlin G. Geiger, president of Davison Chemical Co., a division of W. R. Grace & Co., has been appointed executive vice president in charge of the Grace Co.'s seven chemical divisions. **William E. McGuirk, Jr.,** executive vice president of the company, will succeed Geiger as Davison president.

Glenn F. Thomas and **George W. Brewer, Jr.,** have formed a new company, Thomas & Brewer, with headquarters in Liberal, Kans. Thomas, district geologist for Lion Oil Co., was formerly with Ohio Oil Co. Brewer has been district landman for Lion at Liberal. He was formerly with Continental Oil Co.

Pat Murta, part-owner of Silver Fox Drilling Co., sold his interest in the firm to its president, **John W. Owen.** Murta has opened consulting engineering offices in Tulsa.

Ray E. Plumb, Jr., has joined the Brewster-Bartle Drilling Co. as geologist. Plumb was formerly with Phillips Petroleum Co. and D. D. Feldman Co.

R. R. Gumaer, technical assistant to the vice president of manufacturing for Pan-Am Southern Corp., in New Orleans, has joined American Oil Co. as a chemical engineer in Texas City, Tex.

Frank Steen, Gulf Coast representative for Camco, Inc., for the past 8 years, has joined Southern Geophysical Co. at Fort Worth as assistant to the president. Prior to his service with Camco, Steen worked for Tube-Kote, Inc.

R. R. Dewell, senior process engineer with Phillips Petroleum Co. in Phillips, Tex., has joined Signal Oil & Gas Co. as a plant chemist in Tioga, N. D.

C. D. Ozanich, formerly with Standard Oil Co. of California, has joined the Southern Pacific Pipe Lines, Inc., as corrosion engineer in their Los Angeles office.

Dr. Bernard L. Evering has been appointed a senior research associate in the Whiting, Ind., research department of Standard Oil Co. (Ind.). A pioneer in aviation gasoline research, Dr. Evering has been with Indiana Standard since 1934.

Personals

William A. Patterson, staff geologist with Phillips Petroleum Co. in Bartlesville, Okla., has been promoted to assistant division geologist and transferred to Corpus Christi, Tex.

Harris H. Allen and **D. C. Gilkison** have opened an oil and gas consulting office in Houston. Allen formerly was with Phillips Petroleum Co. and Ada Oil Co. Gilkison formerly was associated with Amerada Petroleum Corp., Phillips, and D. D. Feldman.

J. J. HEDRICK

J. J. Hedrick, president of Natural Gas Pipeline Co. of America, Chicago, was elected president of the Independent Natural Gas Association of America at the annual meeting in San Antonio. He succeeds **John F. Merriam,** president of Northern Natural Gas Co., Omaha. **Glenn W. Clark,** president of Cities Service Gas Co., Oklahoma City, was elected first vice president, and **W. T. Stevenson,** president of Texas Gas Transmission Co., Owensboro, Ky., second vice president. **F. W. Peters,** treasurer of Oklahoma Natural Gas Co., Tulsa, was reelected treasurer, and **John A. Ferguson,** Washington, was reelected secretary.

Paul Gautreaux, chief petroluem engineer for the Mississippi Oil and Gas Commission, has been appointed superintendent of production for Slade Oil & Gas Co. in Monroe, La.

DEATHS

Stuart Miller Crocker, 58, chairman of the board and chief executive officer of Columbia Gas System, Inc., died September 3 in Chatham, Mass. He had served as chief executive officer of Columbia during the past 13 years.

R. G. (Peg) Whealton, 58, West Coast petroleum consultant, died in Pasadena, Calif., recently. During World War II Whealton served as director of production for Pacific Coast District 5.

A. H. (Andy) Rhodes, 64, president of the Root-Rhodes Oil Co., died recently in Fort Worth. Rhodes was a pioneer in the boom days of the Ranger oil discovery in Texas and was active in the Big Lake and East Texas areas.

Raymond A. Earle, 53, president of Weststates Petroleum, died September 4 in San Francisco.

Sam P. Shelburne, 68, president of Shelburne Oil Co., and part owner of Jones-Shelburne Oil Co., died September 7 in Oklahoma City.

Bert G. Williams, 79, once chief engineer for Southern California Gas Co., and later a specialist in measurements, died September 4 in Los Angeles.

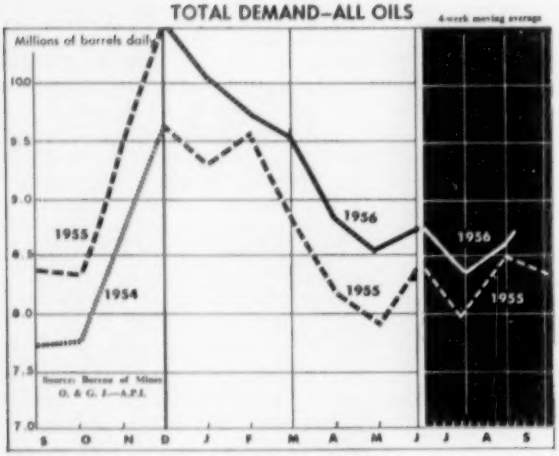
Clifford M. Long, 76, former board chairman of Colonial-Beacon Oil Co. of Boston and of Louisiana Oil Refinery Corp., died September 9 in Lake Forest, Ill.

Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,045,400	DOWN	70,725	UP	312,390
Crude stocks	278,720,000	UP	1,813,000	UP	19,612,000
Completions	1,063	DOWN	27	DOWN	9
Refinery runs	8,187,000	UP	189,000	UP	633,000
Gasoline stocks	175,955,000	UP	384,000	UP	21,618,000
Kerosine stocks	32,698,000	UP	297,000	DOWN	2,903,000
Distillate stocks	142,731,000	UP	4,282,000	UP	4,895,000
Residual stocks	47,198,000	UP	415,000	UP	87,000
Four-product stocks	398,582,000	UP	5,378,000	UP	23,697,000
Total imports	1,304,700	DOWN	63,600	UP	178,700

TOTAL DEMAND—ALL OILS



Suez Closing or Break in Gasoline Market Will Solve Stock Problem

REFINERS in this country seem to be gambling that the trouble over the Suez Canal will get hot enough to close the canal and that the closing will cause a product shortage in Europe.

This is about the only plausible explanation for the continuation of excessive crude runs at refineries. There is no current shortage of any major product and no foreseeable shortage of light fuels for the coming winter unless a major disturbance upsets the supply-and-demand balance.

Refinery runs first topped 8,000,000 bbl. daily in January of this year. The average for the month was 8,023,000 bbl. daily which was followed by 8,047,000 bbl. daily in February. The drop in March to 7,914,000 bbl. daily was enough to hold the average for the quarter to 7,994,000 bbl. daily.

The percentage decrease in runs during the month of April was about normal. April is always the low month of the year for refinery input. The percentage increase from April to May was a little above the average for the past few years. Another increase of 175,000 bbl. daily in June pushed the average for the month up to 8,071,000 bbl. daily.

Weekly figures show monthly averages of 8,011,000 bbl. daily and 7,980,000 bbl. daily for July and August respectively to give an average of 8,020,000 bbl. daily for the June-August period. This was the first 3-month period with an average above 8,000,000 bbl. daily.

The significant factor in this record increase is the fact that the peak level of runs came at a time when total demand for products was much lower than during the winter months. Total demand averaged 9,763,000 bbl. daily for the first quarter of this year when runs averaged a little less than 8,000,000 bbl. daily, but was down to about 8,560,000 bbl. daily for the June-August period when refiners set the all-time record. From the first quarter to the June-August period, runs increased 26,000 bbl. daily while total demand decreased 1,200,000 bbl. daily.

The Suez crisis came early in August and could have been a factor in the continuation of high runs for that month, but the canal problem cannot be used as an explanation for the abnormal runs in June and July.

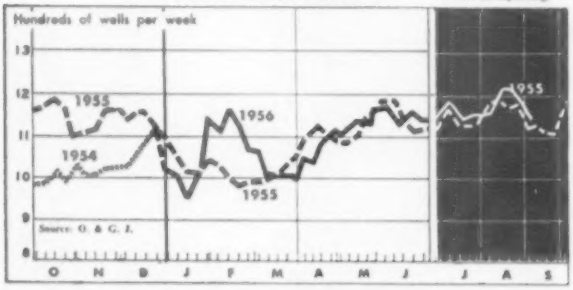
At the end of August, stocks of the four major products topped the total for the previous year by 25,000,000 bbl. Almost 22,300,000 bbl. of the increase was gasoline. Middle distillate was up about 2,500,000 bbl., and residual gained only about 200,000 bbl.

Complete closing of the Suez Canal would produce a situation in Europe that would drain some of the gasoline tanks in this country. A definite break in the gasoline market would slow down the stock increase through lower runs. Neither cure could be called a desirable solution to the stock problem.

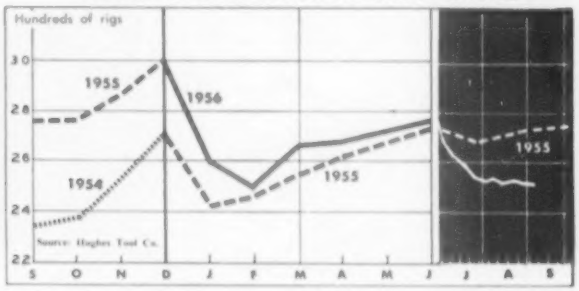
Natural gasoline increased 0.5 cent a gallon at the end of the first week of September. Grade 26-70 advanced from 4.0 to 4.5 cents a gallon on the Breckenridge market, effective September 7. The Group 3 price moved up 0.5 cent to 5.0 cents a gallon the following day.

The seasonal price increases for natural gasoline came early last year with the first raise posted on June 29, followed by a second on September 2.

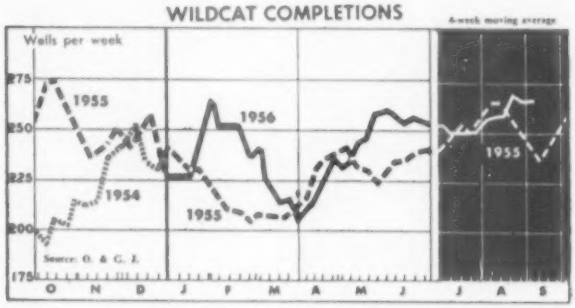
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS*

Area—	9-10-56	9-3-56	9-12-55
North Central and East	114	126	143
Southeast	45	36	36
Okla., Kans., Ark., Mo.	431	448	516
Louisiana	434	440	426
North and East Texas-Panhandle	365	367	381
Gulf and South Texas	237	235	250
West Texas-New Mexico	490	477	489
Rocky Mountain	277	281	329
Pacific Coast	114	113	132
Total United States	2,507	2,523	2,702
Western Canada	255	264	217

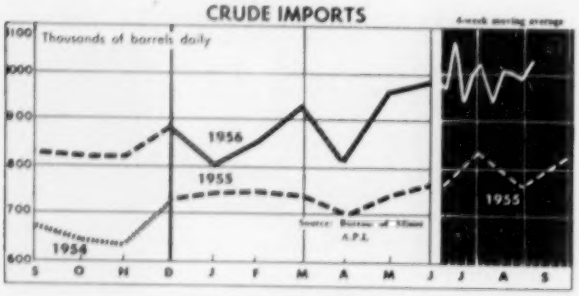
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS . . . WEEK ENDED SEPTEMBER 8, 1956

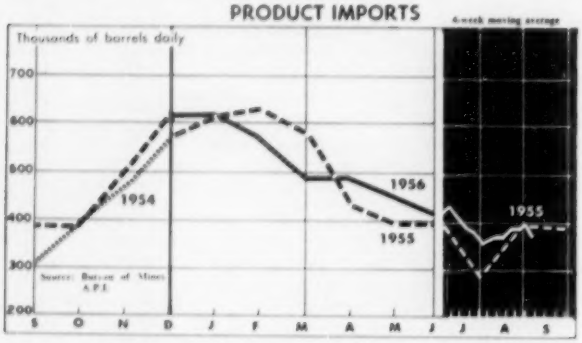
	Total of all wells					Cum		Wildcat completions and discoveries					Cumulative total, 1956				
	Comp.	Oil	Gas	Dry	Footage	1956	1955	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	2	0	0	2	8,305	77	57	0	0	0	1	1	0	0	1	33	34
Arkansas	20	11	0	9	57,584	595	540	0	0	0	6	6	27	0	3	100	130
California	43	30	0	13	165,148	1,520	1,698	0	0	0	12	12	32	0	6	311	349
Colorado	28	8	0	20	121,940	807	1,021	0	0	0	16	16	18	0	11	388	417
Illinois	82	39	3	40	180,981	2,658	2,632	0	0	0	16	16	35	0	3	484	522
Indiana	18	7	0	11	32,147	458	517	0	0	0	3	3	13	0	1	80	94
Kansas	81	31	8	42	276,906	3,499	3,482	1	0	2	13	16	83	2	25	629	739
Kentucky	48	13	6	29	70,038	1,261	999	2	0	0	12	14	30	0	1	271	302
Louisiana	63	31	3	29	464,185	2,635	2,730	1	1	0	15	17	82	39	43	372	536
North	31	15	1	15	144,188	1,130	1,421	0	0	0	10	10	22	2	3	156	183
South	26	14	1	11	263,813	1,208	1,309	1	1	0	4	6	48	33	28	189	298
Offshore	6	2	1	3	56,184	297		0	0	0	1	1	12	4	12	27	55
Michigan	6	2	0	4	16,759	303	363	1	0	0	3	4	7	0	1	107	115
Mississippi	12	3	1	8	80,551	309	309	1	0	0	5	6	13	1	1	132	147
Montana	13	9	0	4	69,518	299	232	0	0	0	3	3	10	0	1	97	108
Nebraska	17	6	0	11	98,244	697	561	1	0	0	10	11	28	0	0	314	342
New Mexico	25	4	17	4	106,282	1,341	1,148	1	0	1	4	6	36	0	8	138	182
Northwest	25	4	17	4	106,282	563	368	1	0	1	4	6	7	0	7	47	61
Southeast	0	0	0	0	0	778	780	0	0	0	0	0	29	0	1	91	121
North Dakota	6	2	0	4	35,130	177	171	0	0	0	4	4	8	0	0	49	57
Ohio	35	17	6	12	66,264	727	825	0	0	0	0	0	0	0	1	5	6
Oklahoma	143	80	3	*60	500,745	5,910	5,922	2	0	1	17	20	87	16	29	486	618
Pennsylvania-New York	2	0	2	0	7,112	756	1,112	0	0	0	0	0	0	0	6	11	17
Texas	383	231	14	138	1,682,891	15,465	13,962	12	2	2	87	103	526	28	127	3,243	3,924
Southwest (1 & 4)	43	18	3	22	190,981	2,215	2,131	3	1	0	18	22	98	6	43	605	752
Gulf Coast (2 & 3)	40	16	4	20	273,635	1,829	1,752	0	1	0	15	16	48	14	46	484	592
East (5 & 6)	27	19	1	7	113,111	803	676	0	0	0	5	5	11	2	5	271	289
N. Central (7-B & 9)	149	91	0	58	462,621	5,546	5,274	9	0	0	33	42	235	0	6	1,311	1,552
West (7-C & 8)	97	71	0	26	516,469	4,143	3,422	0	0	0	14	14	122	0	9	525	656
Panhandle (10)	27	16	6	5	126,074	929	707	0	0	2	2	4	12	6	18	47	83
Utah	4	2	0	2	17,209	89	67	0	0	0	2	2	3	0	3	47	53
West Virginia	10	3	7	0	36,544	450	434	0	0	0	0	0	0	0	6	7	13
Wyoming	22	10	0	12	93,880	576	586	3	0	0	6	9	12	0	7	141	160
Miscellaneous	0	0	0	0	0	70	22	0	0	0	0	0	4	0	0	58	62
Total United States	**1,063**	539	70	454	4,188,363	40,679	39,390	25	3	6	235	**269**	1,054	86	284	7,503	8,927
Total previous week	1,090	574	92	424	4,471,150			25	2	13	223	263	1,029	83	278	7,268	8,658
Total Sept. 10, 1955	1,072	556	71	445	4,287,003			36	1	6	189	232	1,130	147	249	6,840	8,366
Cumulative 1956	40,679	22,098	2,790	15,791	163,710,340												
Western Canada	95	71	6	18	446,521	2,089											

Service wells included: *5.

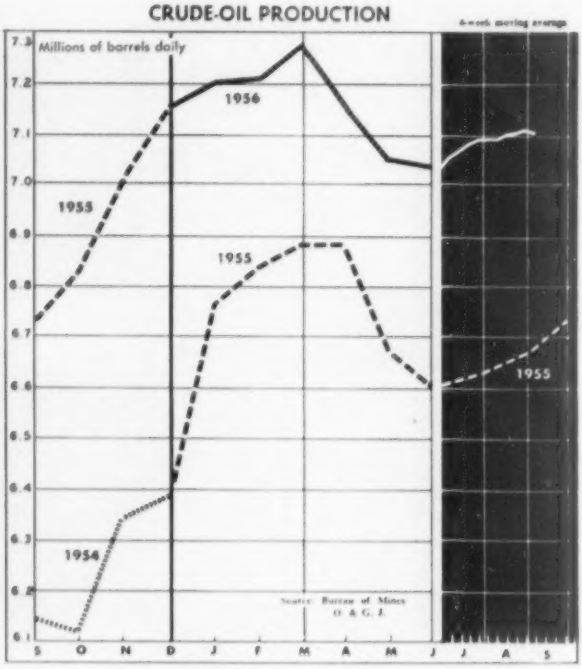
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION

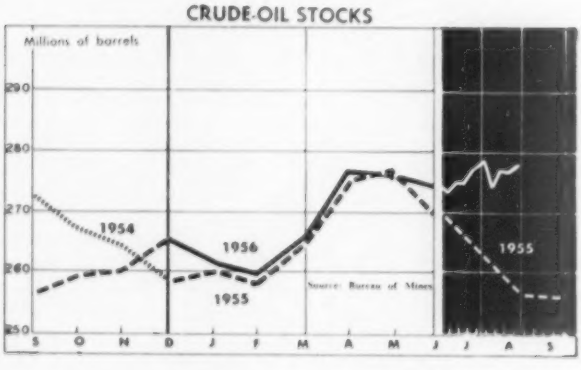


DAILY AVERAGE PRODUCTION FOR WEEK

	September 8, 1956			Sept. 1
	Crude oil	Lease condensate	Total	total
Alabama	9,100		9,100	7,400
Arkansas	79,350	400	79,750	80,000
California	963,000		963,000	962,300
Colorado	158,000		158,000	157,100
Eastern	51,400		51,400	50,800
Florida	1,325		1,325	1,375
Illinois	235,700		235,700	234,300
Indiana	30,800		30,800	30,900
Kansas	335,100		335,100	339,500
Kentucky	46,900		46,900	47,700
Louisiana	732,200	57,200	789,400	788,700
North	119,700	2,200	121,900	121,200
South	612,500	55,000	667,500	667,500
Michigan	29,300		29,300	29,300
Mississippi	108,800	4,625	113,425	112,550
Montana	63,600		63,600	63,100
Nebraska	38,500		38,500	37,200
Nevada	200		200	200
New Mexico	236,900	3,800	240,700	232,900
North Dakota	35,800		35,800	37,500
Oklahoma	563,500		563,500	579,500
Texas	2,914,000	51,300	2,965,300	3,028,300
Dist. 1	56,000	450	56,450	56,425
Dist. 2	143,000	8,100	151,100	153,925
Dist. 3	419,000	24,200	443,200	458,400
Dist. 4	235,000	6,200	241,200	244,700
Dist. 5	42,500	400	42,900	43,350
Dist 6	124,000	5,875	129,875	130,300
East Texas field	202,000		202,000	210,500
Dist. 7-B	159,000	50	159,050	158,050
Dist. 7-C	180,000	3,750	183,750	193,700
Dist. 8	1,040,000	1,600	1,041,600	1,061,500
Dist. 9	213,000	475	213,475	217,300
Dist. 10	100,500	200	100,700	100,150
Utah	7,200		7,200	7,100
Wyoming	287,300		287,300	288,400
Others	‡100		‡100	
Total U. S.	6,928,075	117,325	**7,045,400**	7,116,125
Change from previous week, down			**70,725**	
Canada	†469,000		†469,000	†504,000
Total U. S. production January 1-September 8			§1,801,047,450 bbl.	
Same period last year (crude plus condensate)			*1,692,661,786 bbl.	

*Includes 28,152,800 bbl. condensate. †Week ended previous Monday. ‡S. Dakota. §Revised.

CRUDE-OIL STOCKS



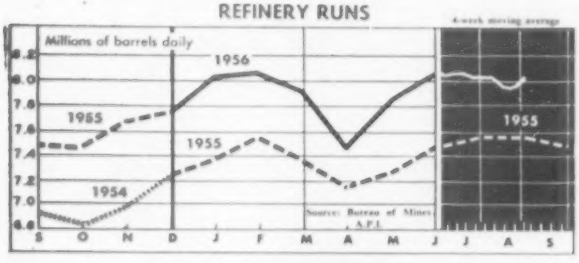
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

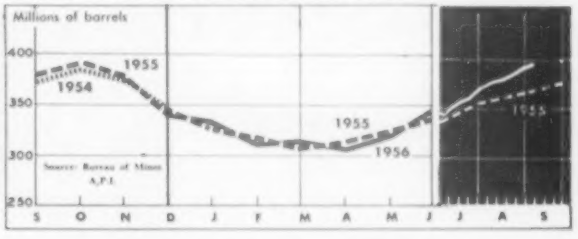
	9-1-56	8-25-56	9-3-55
Pennsylvania Grade	2,512	2,554	3,173
Other Appalachian	2,464	2,084	1,978
Illinois, Indiana, Michigan	10,626	10,822	10,405
Nebraska, North Dakota	2,554	2,360	2,155
Kansas	10,106	9,012	8,287
Oklahoma	26,683	27,231	21,936
Arkansas	3,081	2,707	2,574
Louisiana	17,989	17,181	16,232
North	2,618	2,688	2,608
South	15,371	14,493	13,624
Mississippi	3,085	2,991	2,866
New Mexico	8,136	7,673	7,925
Texas	122,351	121,754	119,944
East Texas proper	8,735	9,359	9,687
West Texas	59,144	58,633	56,124
Texas Gulf	22,815	22,348	23,392
Other Texas	31,657	31,414	30,741
Wyoming	18,092	19,158	15,380
Other Rocky Mountain	6,474	7,291	5,211
California	29,205	28,789	29,651
Foreign	†15,362	15,300	11,391
Total	278,720	276,907	259,108

*Bureau of Mines. †Includes 4,276,000 bbl. in California.

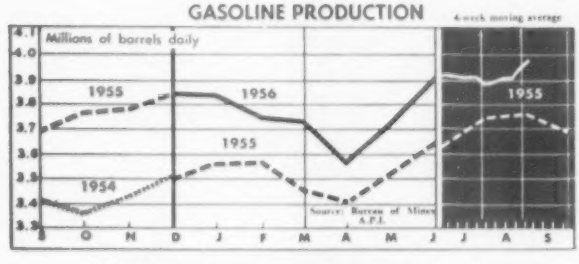
REFINERY RUNS



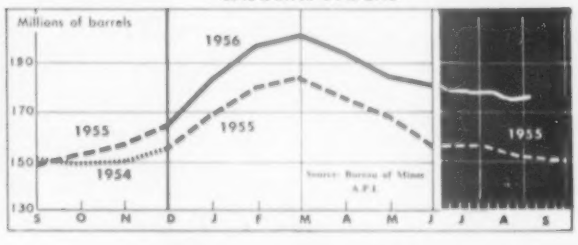
FOUR-PRODUCT STOCKS



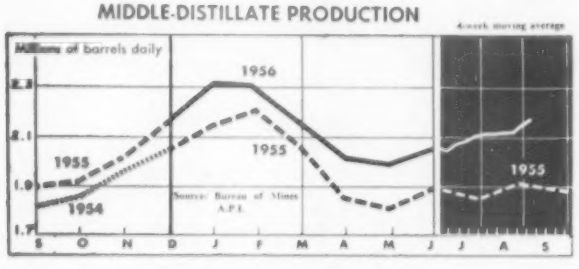
GASOLINE PRODUCTION



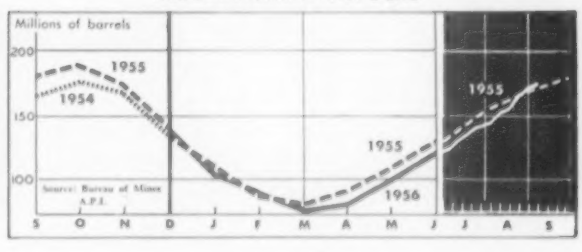
GASOLINE STOCKS



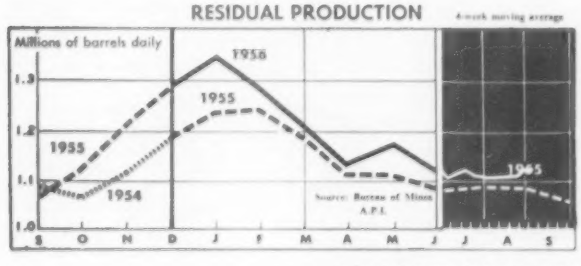
MIDDLE-DISTILLATE PRODUCTION



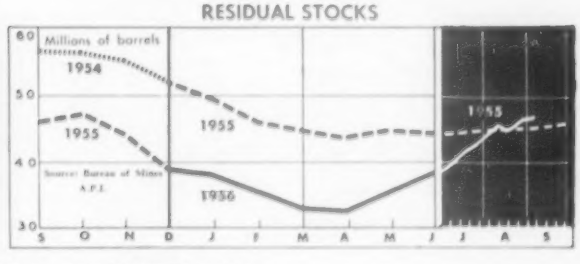
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, SEPTEMBER 7, 1956

(Thousands of barrels)

District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks† Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, September 1955 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,130	493.7	37.1	330.0	183.1	41,617	12,256	51,563	12,339	1,085	463.7	31.5	257.9	191.0
Appalachian:														
District 1	105	48.0	5.1	24.9	3.8	4,529	601	3,216	604	94	40.1	3.8	21.6	7.3
District 2	114	56.4	4.0	19.4	12.1	2,818	789	1,098	508	97	54.7	1.6	14.3	11.0
Ind., Ill., Ky.	1,495	786.9	71.2	314.7	157.6	31,781	7,285	21,264	5,520	1,296	686.7	50.7	250.7	141.7
Minn., Wis., Dak.	87	39.6	9.7	17.0	5.7	6,335	1,594	7,977	181	(§)	(§)	(§)	(§)	(§)
Okla., Kans., Mo.	707	382.7	16.0	171.7	30.6	15,250	2,125	13,565	1,489	703	421.5	21.6	167.2	29.4
Inland Texas	294	209.3	7.0	51.9	24.6	7,243	525	1,923	1,701	264	195.9	7.0	53.0	22.0
Texas Gulf Coast	1,955	948.9	95.4	486.0	235.6	23,729	3,670	16,904	6,312	1,781	845.0	94.6	444.3	218.2
La. Gulf Coast	691	356.4	64.0	182.9	42.7	9,975	2,567	6,513	1,653	662	337.3	53.7	161.8	44.3
N. La. and Ark.	107	42.7	8.0	25.0	9.0	4,907	476	2,067	224	88	33.9	7.4	21.9	5.6
Rocky Mountain:														
New Mexico	23	12.0	0.3	4.3	2.3	459	5	120	30	19	10.2	0.2	3.3	2.7
Other Rocky Mt.	289	131.4	5.9	56.7	37.3	5,328	438	3,320	897	258	119.9	2.5	56.8	36.2
West Coast	1,190	542.4	3.9	184.1	372.7	21,984	367	13,201	15,740	1,136	486.9	4.2	167.7	351.1
Sept. 7, 1956	8,187	4,050.4	327.6	1,868.6	1,117.1	175,955	32,698	142,731	47,198	7,483	3,695.8	278.8	1,620.5	1,060.5
Aug. 31, 1956	8,098	4,030.0	313.7	1,891.6	1,136.0	175,571	32,401	138,449	46,783					
Sept. 9, 1955	7,554	3,739.1	298.4	1,650.9	1,093.7	154,337	35,601	137,836	47,111					

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines. §Included in Ind., Ill., Ky.

Crude-Oil and Refinery Prices at Representative U. S. and Foreign Points

REFINED-PRODUCT PRICES

Following quotations are for refinery products in cents per gallon moving in interstate shipments on Wednesday each week unless otherwise noted. Crude-oil prices are per barrel at the wells unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
Regular (88 octane)	11.25-11.75
Premium (96 octane)	13.00-13.50
Gulf Coast (cargoes for coastwise or export movement):	
Regular (90 octane)	11.00-11.50
Regular (92 octane)	11.25-11.75
Premium (97 octane)	12.75-13.25
Premium (98 octane)	13.00-13.50
California—Los Angeles (rack):	
★ Regular (84 octane)	12.1-12.6
★ Premium (93 octane)	13.35
★ Premium (96 octane)	14.3-14.6
Caribbean area (cargoes):	
Regular (87 octane)	10.50
Premium (93 octane)	11.75

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

NATURAL GASOLINE*

Group 3:	
★ Grades 26-70	5.0
Breckenridge:	
★ Grade 26-70	4.5

*If 26-70 natural is considered as 100 per cent, prices for lower-vapor-pressure grades increase 2.5 per cent for each unit drop in Reid vapor pressure down to and including 16-lb. Prices for grades below 16-lb. may vary slightly by areas or plants.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
Kerosine 42-44	9.75-10.00
Diesel oil (58 d.i. and above)	9.625-9.875
Distillate No. 1	9.625-9.875
Distillate No. 2	8.75-9.00
Gulf Coast (cargoes):	
Kerosine 41-43	9.125
Distillate No. 2	8.50
New York Harbor (barges):	
Kerosine 41-43	10.85
Distillate No. 2	10.35
Diesel fuel, 48-52 d.i.	10.65
Caribbean area (cargoes):	
Distillate No. 2	8.50

WAX (LB.)

Oklahoma (Group 3):	
132-135 A.m.p. (semi-refined) in tank cars	6.50
New York (export):	
126-130 A.m.p. crude scale (solid in bags or barrels)	7.35

★Denotes change from previous week.

RESIDUAL FUEL (BBL.)

Mid-Continent (Group 3):	
Residual fuel (max. 1% S)	$2.00-2.10
Gulf Coast (cargoes):	
Bulker C fuel	$2.10
New York Harbor (barges):	
Bunker C fuel	$2.80
Caribbean (cargoes):	
Bunker C at Aruba, N.W.I.	$2.10
California (rack):	
Bunker C fuel, Los Angeles	$2.15-2.25

LUBRICATING OILS

Mid-Continent (Group 3):	
150-160 bright stock, solvent refined, 0-10 p.p., 95 v.i.	24
200 vis. neutral oil, solvent refined, 0-10 p.p., 95 v.i.	20.75
Pennsylvania Grade:	
145-155 vis. at 210, bright stock, 8 color, 25 p.t.	27
200 vis. neutral (180 at 100°), 25 p.t.	25

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.	Mid-Cont.*	Gulf Coast Tex.†	West Tex.‡ N.M.	Wyo. (sour)
14-14.9	$2.02	....	....	....	....
15-15.9	2.98	....	....	....	....
16-16.9	2.13	....	....	....	....
17-17.9	2.19	....	....	....	....
18-18.9	2.24	....	....	....	....
19-19.9	2.30	....	....	....	....
20-20.9	2.35	$2.50	....	$2.37	....
21-21.9	2.41	2.52	....	2.39	....
22-22.9	2.47	2.54	....	2.41	....
23-23.9	2.52	2.56	....	2.43	....
24-24.9	2.58	2.58	$3.01	2.45	....
25-25.9	2.64	2.60	3.03	2.47	$2.13
26-26.9	2.69	2.62	3.05	2.49	2.19
27-27.9	2.76	2.64	3.07	2.51	2.24
28-28.9	2.83	2.66	3.09	2.53	2.29
29-29.9	2.91	2.68	3.11	2.55	2.34
30-30.9	2.97	2.70	3.13	2.57	2.39
31-31.9	3.04	2.72	....	2.59	2.44
32-32.9	3.12	2.74	....	2.61	2.48
33-33.9	3.20	2.76	....	2.63	2.52
34-34.9	3.27	2.78	....	2.65	2.56
35-35.9	3.34	2.80	....	2.67	2.60
36-36.9	3.39	2.82	....	2.69	2.64
37-37.9	....	2.84	....	2.71	2.66
38-38.9	....	2.86	....	2.73	2.68
39-39.9	....	2.88	....	2.75	2.70
40 and up	....	2.90	....	2.77	2.72

*Includes Oklahoma, Kansas, North Dakota, West Texas (sweet), North Central Texas, North Louisiana, Arkansas. †Low-cold-test Gulf Coast. ‡Sour.

Effective dates: California, February 7, 1956; east of California, June 15, 1953; Pennsylvania Grade, August 16, 1956.

Some crudes in North Central Texas, West Central Texas, and Texas Panhandle have been shifted to the intermediate schedule with $2.83 for 40° and 2 cents per degree drop. Effective dates range from July 15, 1956, to August 10, 1956.

FLAT PRICES

Louisiana:	
Cotton Valley (distillate)	$3.00
Cotton Valley (Holloway crude)	2.95
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	4.68
Middle District	4.50
Southwest Pennsylvania	4.21
West Virginia	4.03
Buckeye Grade	4.07
Zanesville Grade	3.15
Illinois Basin	2.90
Canada:	
Leduc-Woodbend (flat prices D-2, D-3)	2.60
Redwater (Alta.) D-3	2.49
Smiley-Viking (Sask.)	2.26
Fosterton (Sask.)	1.29
Pembina	2.52

FOREIGN

Venezuela:	
Cumarebo, 48°-49.8°, Tucupido	*3.40
San Joaquin, 41°-41.9°, Puerto La Cruz	*3.04
Oficina, 35°-35.9°, Puerto La Cruz	*2.80
Tia Juana medium, 26.5°-26.9°, Amuay§	†2.30
Quiriquire, 16.5°-16.9°, Caripito	‡2.21
Lagunillas heavy, flat, Amuay or Las Piedras§	2.05
Bachaquero, 16.5°-16.9°, Amuay or Las Piedras§	‡1.90

*Plus or minus 2 cents per barrel for each degree gravity change. †Plus or minus 2.5 cents per barrel for each half-degree gravity change. ‡Plus or minus 3.5 cents per barrel for each half-degree gravity change. §Also available at La Salina at 3.0 cents per barrel less.

Middle East, Persian Gulf (cargoes, f.o.b. lifting port):	
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Iranian, 34.0°-34.9°, Bandar Mashur	1.91
Iranian, 34.0°-34.9°, Abadan	1.86
Iraq, 36.0°-36.9°, Fao	1.87
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.72
Qatar, 39.0°-39.9°, Umm Said	2.06
Middle East, E. Mediterranean:	
Arabian, 36.0°-36.9°, Sidon	2.46
Iraq, 36.0°-36.9°, Tripoli, Banias	2.46
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BOX J-794,
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Major Oil Company has openings in Production Dept. in Venezuela for a number of graduate petroleum engineers.

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Please send details of Experience to:

P. O. BOX NO. 35
BOWLING GREEN STATION
NEW YORK 4, N. Y.

HELP WANTED

FIELD ENGINEER WANTED. Oil Well drilling tool manufacturer has opening for Field Engineer familiar with rock bits. Should have technical education with some design experience. Excellent opportunity in an expanding Engineering Department. Write giving details of education and previous experience to Box J-720, The Oil and Gas Journal, Tulsa, Oklahoma.

PROCESS DEVELOPMENT

An unusual opportunity to join an expanding development laboratory located adjacent to the production facilities which it serves. Results of development work are transferred into plant practice under the cooperation and observation of laboratory personnel. These positions afford an excellent opportunity to become thoroughly familiar with the development and operating viewpoints.

Applicants must have sound technical training from recognized curricula. Openings are available for:

CHEMICAL ENGINEERS

B.S. or Ph.D. up to eight years of industrial experience.

CHEMISTS

Analytical (B.S. or M.S.) and Physical (M.S. or Ph.D.) up to eight years of industrial experience.

These are permanent positions located in Texas. Salary will be commensurate with the qualifications of the applicant.

Please send brief resumé of education and industrial experience, and approximate salary requirements to:

L. H. SNYDER,
Employment Manager
ATLAS POWDER COMPANY
Wilmington 99, Delaware.
All replies will be held in strict confidence.

BECHTEL

SAN FRANCISCO CALIFORNIA

Offers engineers liberal relocation allowances from the point of employment to the engineering office in San Francisco. These allowances include transportation for you and your family plus moving allowances for your household furnishings.

PIPELINE ENGINEERS
SENIOR ELECTRICAL
SENIOR MECHANICAL

San Francisco opportunity for senior electrical or mechanical engineers with experience on oil pipeline and pumping stations or gas pipeline and compressor stations.

Send resume to Manager of Employment & Placement
Industrial Relations Division

BECHTEL CORPORATION
220 Bush Street
San Francisco 4, Calif.

For an immediate personal interview you may phone:

Paul Keating, PLaza 7-4400, New York City
Joe Braddick, FAirfax 3-2401, Houston, Texas
Bill Milligan, TUcker 1549, Los Angeles, Calif.
Don Palmer, DOuglas 2-4032, San Francisco, Calif.

HELP WANTED

OIL INDUSTRY Employment Service, 405 Tuloma Bldg., Tulsa, Okla., GI 7-5974, Tom Robinson, owner. For graduate, experienced engineers under 35.

FOREIGN DOMESTIC EMPLOYMENT. List oil companies, drilling contractors, showing where apply foreign jobs $5.00 cash. List 100 large domestic oil companies $5.00 cash. OIML Co., Box 2603, Tulsa, Okla.

SALES ENGINEER For California Oil Fields. Must have wide experience in selling, servicing, engineering and supervision of the installation of equipment for the treating, dehydrating, separating and handling of petroleum production. Chemical or petroleum production engineer preferred. Offshore production equipment experience helpful. Give complete details in first letter and salary requirements. Box J-709, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED

Pilot with geological training and background to fly well equipped Beechcraft Bonanza, based in Houston, Texas. This is an excellent opportunity for a capable man with these combined talents. Starting salary commensurate with qualifications. Please give full details in letter of application.

Address:

BEECHCRAFT DISTRIBUTOR,

Box 681, Shreveport, La.

Refinery and Chemical Plant ENGINEERING

Several qualified graduate engineers – Chemical, Mechanical, or Petroleum – can broaden their professional responsibilities in the Chemical Engineering Department of C F Braun & Co.

Assignments will cover a wide variety of plants, ranging from complete integrated refineries and chemical plants through all types of individual process units.

The work includes coordination of chemical engineering, selection and design of process equipment and machinery, engineering, selection and specification of instrument systems, and startup of completed plants.

Top salaries, fine facilities, profit-sharing retirement plan. Write to the head of our Personnel Department, Mr F B Stratford.

C F BRAUN & CO
ALHAMBRA CALIFORNIA
Engineers
Consultants Constructors

HELP WANTED

PROCESS ENGINEER for major oil company, must be graduate Chemical Engineer. Address all replies giving age, education, experience and salary expected to Refinery Personnel, P. O. Box 381, Tulsa.

DIVISION GEOLOGIST—Independent Oil Company desires man under 40 with 10 years experience in Kansas and Oklahoma. Furnish resume of experience and education. Box J-719, The Oil and Gas Journal, Tulsa, Oklahoma.

HYDRAULIC CASING pulling unit operators and helpers. Call GLadstone 3-6551, Great Bend, Kansas.

NATURAL GAS ENGINEER with engineering degree plus experience in plant design or operation. Location Tulsa. Amerada Petroleum Corporation, Gas Department, P. O. Box 2040, Tulsa, Oklahoma.

ENGINEERS

Chemical, Mechanical, Petroleum, Gas Engineering Graduates. Our company will interview applicants for openings in our natural gas-gasoline department in Mid-Continent, Louisiana, Gulf Coast areas. Two years minimum design and/or operation experience. Salary to suit qualifications. Our employees are aware of this ad. Box J-721, The Oil and Gas Journal, Tulsa, Oklahoma.

DRILLING ENGINEERS
FOREIGN DRILLING OPERATION

Oil well drilling contractor has immediate opening for drilling engineers in Sicily and Africa. Liberal salary and bonus. Box J-679, The Oil and Gas Journal, Tulsa, Oklahoma.

VALUATION ENGINEER

Petroleum Engineer with experience in appraisal and reservoir work wanted by permanently established independent oil company. Position requires practical as well as technical knowledge in the evaluation and financing of producing property purchases, and in administrative procedure. Must have the ability and initiative to develop necessary contacts in the active regions of the oil country. Reply should state age, education, experience, active references, and starting salary required.

BOX J-690,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

MAINTENANCE ENGINEERS

Immediate openings for Planning and Scheduling and Area Maintenance engineers are available in the Maintenance Section of our Petrochemical Plant located on the southern Texas gulf coast. For these openings we would prefer applicants with related experience backgrounds; however, experienced mechanical engineers will also be considered. In addition, openings are available for which applicants with other types of engineering backgrounds will be considered. These openings are at junior, intermediate and advanced employment levels in applicable engineering work.

Positions offer stable employment, advancement opportunity with newly established and growing organization, and a liberal, well balanced group of employee benefit plans. Salaries will be commensurate with training and work experience.

Forward complete employment resumé together with a recent photograph, details concerning age, marital status, educational background and salary requirements. All replies confidential.

STANOLIND OIL AND GAS COMPANY
EMPLOYMENT OFFICE
P. O. BOX 1712
BROWNSVILLE, TEXAS

SITUATIONS WANTED

EX-NAVY PILOT, 34, ATR, 3700 hours Cubs to Constellations. Call or Write J. A. Newborn, Jr. Liberty, Texas.

ASST. DIVISION Exploration Manager. Age 35. Petroleum Geologist Degree. Desires key position with substantial independent or independent company. 12 years diversified experience Ark.-La.-Tex., Southern Canada, Williston Basin, West Texas and portions Mid-Continent and Rocky Mtn. areas. Presently employed major independent company. Past four years in advanced supervisory capacities with management training. Box J-703, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST—Graduate Geologist, Geophysicist, with 18 years experience throughout most major areas of United States, seeks responsible position with independent oil company operating in the Mid-Continent or Rocky Mountain regions. Box J-716, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST: B.A. Geology, 1 year graduate work, 2 years experience. 25, married with family, desires position offering responsibility and opportunity. Available immediately. Box J-717, The Oil and Gas Journal, Tulsa, Oklahoma.

SEISMOLOGIST-PARTY CHIEF, family, six years major company Venezuela, desires position office seismologist, administrator field parties, etc., in U.S.A. or Canada. Willing undergo training if necessary. Box J-722, The Oil and Gas Journal, Tulsa, Oklahoma.

MATERIAL MAN: Twenty years diversified experience in material control, coordination, inventory, accounting, purchasing, liaison. Available September 15th. Box J-723, The Oil and Gas Journal, Tulsa, Oklahoma.

LANDMAN with extensive experience, legal background, will represent individual or group desiring to enter Gulf Coast area, handling drilling deals, farmouts or royalties. HARVEY SCHMIDT, Box 7091, New Orleans 19, Louisiana.

GEOLOGIST, 32, 5 years diversified major company experience in North Texas. Can find oil for interested operator for override and nominal salary. Currently employed. Box J-715, The Oil and Gas Journal, Tulsa, Oklahoma.

DISTRICT LANDMAN fifteen years with present Major Company now located in New Orleans desires change would prefer move to Houston with smaller Company or independent. Box J-702, The Oil and Gas Journal, Tulsa, Oklahoma.

DIVISION ENGINEER with major oil company desires production or staff work with independent. Twelve years experience in foreign, Mid-Continent, Rocky Mountain and southern areas. Box J-706, The Oil and Gas Journal, Tulsa, Oklahoma.

OIL ACCOUNTANT, 11 years with Independent Company, requiring initiative and executive ability. Wants job with Independent or operator. Consider salary and/or participation. Principle experience, Oklahoma and Kansas. Write Brooks, P. O. Box 783, Chickasha, Oklahoma.

EXECUTIVE—Eighteen years experience all phases Refinery and Chemical Plant design construction operations. Presently executive officer Foreign division of major American Engineering Contractor. Desires domestic employment. Reply Box J-683, The Oil and Gas Journal, Tulsa, Oklahoma.

RETIRED DRILLING CONTRACTOR

Only 41, independent income, executive & organizational ability. Free to travel & will invest full time plus 23 yrs. exp. in Oil, Gas & Mining in Tri-State, Mid-Continent & Rockies. Desires challenging opportunity above high salary. Replies strictly confidential. References on request.

Box J-718, The Oil and Gas Journal, Tulsa, Oklahoma.

ELECTRIC LOG CABINETS

FOR ECONOMICAL FILING of full-size electric logs, most geologists prefer Kraftbilt E-24 4-drawer cabinet. Two compartments to each drawer with separate follow blocks make this cabinet handy, economical. For filing reduced electric logs, geologists use Kraftbilt E-28 8-drawer cabinet. Send for new Catalog 1156-B. Ross-Martin Co., P. O. Box 869-A, Tulsa 1, Okla.

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OFFERING CHOICE ROYALTIES ahead of drilling, in major company blocks. You can make small investments. A. S. Berry, P. O. Box 1383, Tulsa, Oklahoma.

HIGHEST PRICES PAID for choice oil and gas income royalties, overrides, oil properties. A. S. Berry, P. O. Box 1383, Tulsa, Oklahoma.

LEASE AND DRILLING BLOCKS

FOR SALE or Development, large lease acreage over Oil Surface Seepage area. Contact E. A. Munyan, 102 Fairview Drive, Fairfax, Va.

EASTERN KANSAS, 700', 27 API stripper extension. Large estimated reserves if test holes prove trend indicated by recent drilling. Owner, Box 393, Lawrence, Kansas.

NEW MEXICO Oil Leases, Various Blocks. 40 acres $125. Write Box J-701, The Oil and Gas Journal, Tulsa, Oklahoma.

160 ACRE Utah Oil Lease. Bargain, on structure near gas wells. Owner: R. Barnsley, 950 Lincoln Ave., Palo Alto, Calif.

FOR SALE. $500 buys 1/8 working interest to drill No. 1-A well complete into oil zone; this well now staked in line with well that made over 90 barrels per day. Also have another 160 acre proven lease that had 70 barrels daily production in 1918, and has new drill location staked to offset this old well. Will sublet this lease free of acreage bonus to reliable party for 1/8 override royalty. Details write, P. O. Box 315, Coweta, Oklahoma.

MONTANA mountain front, 10 pays, 3300 ft. Consider deal drill offset. Box 801, Conrad, Montana.

CONTACT A. L. BOWLES, Box 947, Ada, Okla., for attractive drilling deal in Seminole Co., Okla., or will drill well selling 1/4 to 1/2 interest.

I HAVE 500 ACRES of land leased in Sections 29 & 30; 5 North; 5 East; Clay County; Illinois, 1½ mile from production. Also, 500 acres in Sections 14, 15, 22 and 23; 16 North; 9 East; Douglas County, Illinois. Will turn for drilling commitment. Leo H. Graves, Phone 2641, Farina, Ill.

FOR SALE: Oil lease of 100 acres located near St. Jo, Texas, with one producing well. Other possible drilling locations that look good. Reasonably priced. Write W. E. Davis, Acme Equipment Co., 126 S. Clinton St., Chicago 6, Illinois, or phone ANdover 3-3430.

640 ACRE FARM OUT, Nemaha County, Kansas, adjoining Hunton and Viola production quarter mile. One well, complete pumping equipment on lease. R. D. Swan, 818 Kennedy Bldg., Tulsa, Oklahoma.

North Chaves County, N. M.

Recommend to small or large buyers leases & royalty in Major Company blocks. Drilling or to drill. Developments indicate great potential possibilities. Data on request.

W. J. PETERMAN, GEOLOGIST
Exploration 1918-1956 Engineering
Portales, New Mexico

PRODUCTION WANTED

WANT TO BUY—Oil Properties, settled or semi-settled production. 100 to 5,000 barrels daily in Oklahoma and Kansas. Contact Morris Sitrin, 1215 First National Building Tulsa, Oklahoma.

PRODUCTION FOR SALE

FOR SALE: 120 barrel per day production. Established water flood leases. 735 acres left to be drilled in proven area. Excellent reason for selling. Baldwin Production Corporation, Route 5, Medina, Ohio.

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SCOUTING AGENCY

Reports—maps—newsletter
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Mail: Apartado 3963
N. VanMiddlesworth
Phone: 54 48 02

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Delaware Corporations formed and serviced. American Guaranty & Trust Company, P. O. Box 487, Wilmington, Delaware

BUSINESS OPPORTUNITIES

FINANCIAL CONTACTS. Underwriters, Brokers, Private Finders of Capital reached. No shopping. Confidential. FREE ENTERPRISE ASSOCIATES 817—51st St., Brooklyn, N. Y.

INTERESTING MINING COMPANY

Will transfer my interest in thirteen uranium mining claims for highest cash and retaining percentage by October 16th, 1956. Located in Gardner Basin, Huerfano County, Colorado. Recorded at Walsenburg County Clerk, Colorado.

WALTER G. MEYERS,
2448 No. Dousman St.,
Milwaukee 12, Wisc.

MINERAL PARTNER

Responsible, who is willing to divert some excess Tax Moneys to plot ore beds, do assay work on existing samples of Iron, Nickel, Chrome and Gold ores already on hand from 4" drill cores old hidden lava flows. Knowledge of mineral geology helpful but not as essential as ability to contact mining interests. Land Titles on 50-50 Basis.

Paul F. Var, Electrical Engineer
P. O. Box 255 R.D. #1
Petersburg, N. Y.

LEGAL

Pursuant to the provisions of Chapter 150 of the General and Special Laws of the State of Texas, passed by the 45th Legislature at its Regular Session, as amended by Senate Bill No. 248, passed by the 53rd Legislature at its Regular Session, the Board of Directors of the Agricultural and Mechanical College of Texas hereby offers for sale at public auction in the Office of the Comptroller, Room 202, System Administration Building, College Station, Texas, at 10:00 a. m. Thursday, September 20, 1956, the oil, gas and sulphur lease on two hundred ninety-eight and two tenths (298.2) acres of land, more or less, being 66.1 acres, more or less, of a survey of 640 acres, granted to L. F. Roberts, assignee, Key West Irrigation Company, Abstract No. 375, by Patent 340, Vol. 30, of date June 30, 1878, and 232.1 acres, more or less, a part of a survey of 4,605 acres originally granted to Teodora Molino, as a Colonist, in the Powers and Hewitson Colony, by Title No. 62, Abstract No. 42, Vol. 60, dated August 3, 1835, said land being the same land described in a deed of trust executed by A. J. Barber and wife, Cornelia M. Barber, to M. H. Gossett, Trustee, dated February 14, 1922, recorded in Vol. 15, page 371, Deed of Trust and Mortgage Records of Bee County; and being the same land conveyed to the State of Texas by the Federal Land Bank of Houston by deed dated November 4, 1937 recorded in Vol. 117, pages 300 et. seq. Deed Records of Bee County, Texas. Only cash bids will be considered. The right is reserved to reject any and all bids. For lease forms and particulars, address COMPTROLLER, Texas Agricultural and Mechanical College System, College Station, Texas.

Lacy Joins Portable Bridge in Sales Post

George H. Lacy has joined Portable Bridge & Equipment Co., Housh Drilling Co., Housh oil producing and other Housh enterprises, it has been announced by Cecil N. Housh and Lester G. Housh, owners.

Lacy's major assignment with Portable Bridge & Equipment is sales promotion of general fabrication items for the oil and heavy construction industries.

Lacy recently retired as chief civil engineer, Houston division of Gulf Oil Corp.

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LEGAL

SEALED BIDS will be received until 2:00 P.M., Mountain Standard Time, October 10, 1956 and opened at that time in the Office of the Superintendent, Blackfeet Indian Agency, Browning, Montana, for the leasing of 2,928.47 acres of Tribal land and 170.92 acres of allotted Indian land located in Townships 31 North, Range 5 West; 31 North, Range 6 West; 32 North, Range 5 West; 32 North, Range 6 West and 34 North, Range 6 West, P.M.M., Glacier and Pondera Counties, Montana, for oil and gas leasing purposes. The details of the lease offering and how and where to file bids may be obtained by addressing the inquiry to the Superintendent of the Blackfeet Indian Agency, at Browning, Montana. Charles S. Spencer, Superintendent.

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OIL BASE	**PETROJEL**	Thickened crude, kerosene, or diesel fuel. Sand.	Oil or gas.	Primarily for use in formations with low acid solubility. Friction loss is lower than that of refined frac oils. Controlled fluid loss. Can be used at temperatures up to 200°F.
OIL BASE	**PETROFRAC**	Thickened crude, diesel fuel, or distillate. Sand.	Oil or gas.	Especially useful for treating wells with low bottomhole pressure. Use of high-gravity crudes makes it possible to fracture gas wells where heavier oil mixtures might be undesirable.
OIL BASE	**SANDFRAC**	Crude or refined oil. Sand.	Oil or gas.	For all types of formations—particularly suited to those of low acid solubility. Low fluid loss. Demulsifying agents may be added.
ACID BASE	**ACID PETROFRAC**	Acid-in-oil emulsion—using crude, kerosene, distillate, or diesel fuel. Acid is 90-95% of total volume. Sand.	Oil or gas.	Primarily for use in acid-soluble formations. Silicate control; retarded acid action; controlled fluid loss. Acid concentration can be varied from 1 to 15%.
ACID BASE	**FRAC ACID**	Thickened acid. Sand.	Oil, gas or water.	Primarily for use in acid-soluble formations where fracturing and acidizing are both desirable.
ACID BASE	**STRATAFRAC**	Acid-kerosene emulsion. Sand.	Oil or gas.	Primarily for use in acid-soluble formations. Acid concentration can be varied.
WATER BASE	**RIVERFRAC**	Fresh or salt water. With or without sand.	Oil, gas; water injection, disposal and supply.	For all types of formations. The use of water practically eliminates the fire hazard.
WATER BASE	**WATERFRAC**	Thickened fresh or salt water. Sand.	Oil, gas; water injection, disposal or supply.	Primarily for use in formations in which the use of oil-base treating materials might be undesirable or detrimental.

8 basic ways Dowell fractures wells

each treatment is selected and tailored to fit your well

Widest variety of fracturing services and materials in the oil industry

F.L.A.—Added to the treating fluid, this easy-to-use powder substantially lowers the fluid-loss characteristics.

FIXAFRAC—A Dowell service that temporarily seals initial fractures, or permeability already present, to permit a concentrated fracturing or acidizing attack on other sections of the pay formation.

MUD ACID—A Dowell acid that dissolves clay minerals and destroys the swelling properties of bentonitic material. As a spearhead, it increases treating effectiveness by cleaning formation face.

ACID INHIBITORS—Dowell acid inhibitors provide maximum protection to metal up to 350°F., yet allow full treatment effectiveness.

ADDITION AGENTS — Dowell engineers use a wide variety of addition agents in tailoring fracturing treatments to fit your wells. These agents control swelling of clay minerals and other silicates, lower surface tension, minimize formation of emulsions, speed up or retard reaction rate of acids with dolomites, etc.

HIGH INJECTION RATE—Special-built Dowell equipment provides better distribution of sand and treating fluid. More of pay zone is treated. Results have shown more production and slower decline.

MODERN EQUIPMENT — Typical of the Dowell look to the future is the development of the rugged Allison-powered pumping unit with its 1500-h.p. aircraft engine. The Allison, the new 60-barrel-per-minute blender and the revolutionary Remote Control Panel bring new power and safety to fracturing and acidizing.

In the field, in treatment after treatment, this rugged Dowell pumper has proved its dependablity in oil and gas wells.

For more information, or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. I-11.

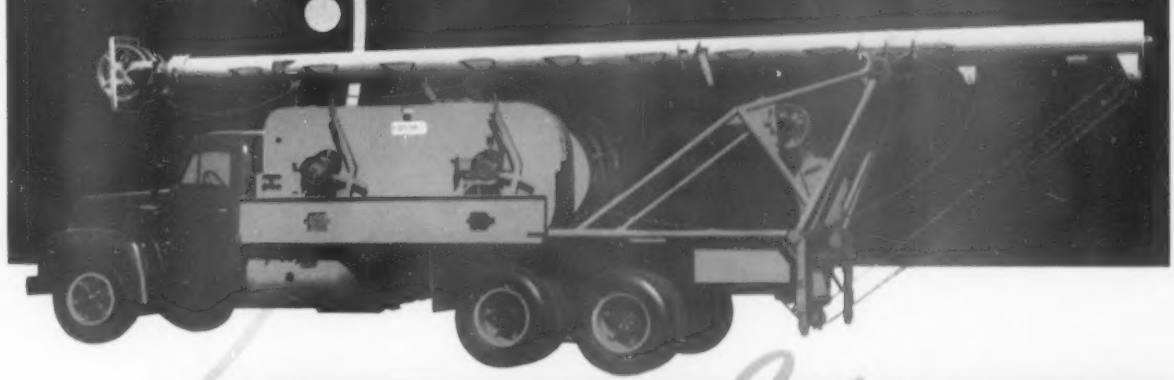
services for the oil industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

FASTER MOVES
FASTER PULLING

. . . WITH 'ROUND THE CLOCK RUGGED DEPENDABILITY



FRANKS *Cruiser*

Franks Cruiser, the most widely accepted pole mast well servicing unit, has set the standard of performance and economy for rod and tubing jobs.

Franks Cruiser is especially economical in areas where there is considerable waiting time on such operations as swabbing.

Franks Cruiser is legal in weight; affords faster moving; faster rig-up and down; and is known for its ruggedness and dependability.

Contractors like Franks Cruisers because superintendents prefer them on their servicing jobs.

Only Franks offers "On the Spot" field service with stock of parts and factory trained personnel available at Alice, Compton, Casper, Farmington, Great Bend, Houston, Kilgore, Odessa, Seminole, Edmonton and Tulsa.

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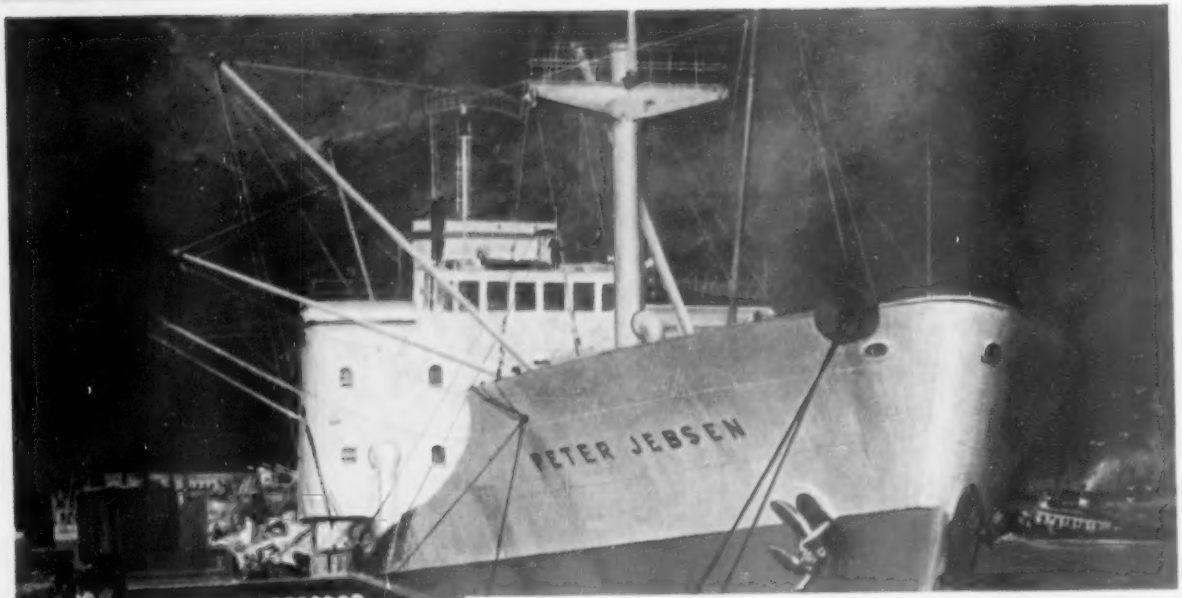
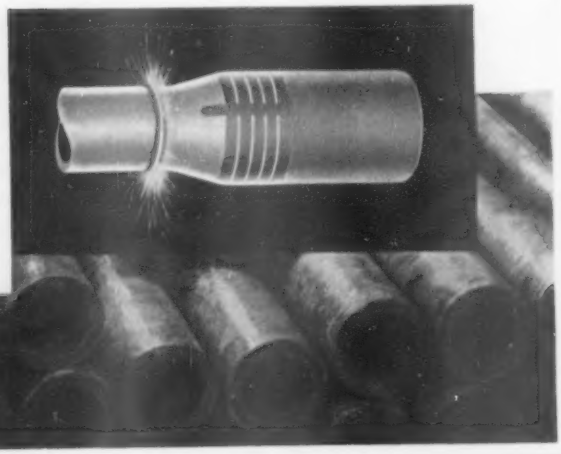


More "Flash-Weld" joints from Hughes are going overseas

The proved *economy* and *dependability* of Hughes "FLASH-WELD" tool joints is resulting in their increased use overseas. And here is why:

1) Hughes' hardfaced "FLASH-WELD" joints last the life of the drill stem — *don't have to be replaced.* And they may be safely rehardfaced in the field.

2) Hughes' "FLASH-WELD" joints eliminate the burden of replacement inventory, also the duty and cost of transporting and handling extra joints.

3) The highly specialized machines and processes pioneered and developed by Hughes exclusively for flashwelding tool joints to pipe assure a superior, more dependable drill stem.

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